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TO ADVERTISERS

CHANGES for advertisements should be in this office by Friday noon for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than Monday noon to assure publication in that week's issue.

OPEN FUSES.

The daily press reported recently a serious accident at a lighting station in New York city, caused by the blowing out of a large fuse. The switchboard attendant, who was standing in proximity to the fuse, was very seriously burned. During the early days of electrical development the necessity of protecting the machinery against accidents to the circuit resulted in the invention of the fuse, and it can not be denied that this simple device has again and again prevented serious damage to the generating station. But is there any longer an excuse for using open fuses, particularly on switchboards where a man is kept in attendance constantly? There are a number of satisfactory enclosed fuses, the use of which would eliminate this risk, and there seems to be little reason why some one of these should not be used on all switchboards where fuses are deemed necessary.

THE SOCIALISM OF INVENTION.

The development of invention has added to the potency of humanity in the measure that it has supplanted brawn by brain. Gunpowder has replaced by the marksman's skill the might of the arm that swung the truncheon, and as nerve has supplanted muscle, what is nerve but branches of the brain? Passing by the services of railway and steamship, the work of the electrician has contributed to the scope of human power in the increase of available time through its means of illumination, and has diminished unavailable time in speedy transportation and the instantaneous transmission of intelligence.

When the first telegraph was introduced it was opposed by the elder Bennett of the New York *Herald* because he foresaw that it would give to the many a rival to his pony expresses which raced to New York with the news for his journal. But when the telegraph was once established, he naturally became one of its most liberal patrons.

Artificial light increases the hours of useful work and therefore of production during the short days of winter, but such illumination was imperfect, especially when a discrimination of color tints was required, until electric lighting was applied. One Manchester cotton manufacturer stated that there was always a difference in the quality of winter and summer goods on account of the greater proportion of "seconds" made under artificial light until electric lighting was introduced into the works, and now that distinction has ceased, and what humanitarian can state the measure of the improvements of the conditions of the operatives resulting from the supplanting of the air-vitiating gas jets by the electric light? Rapid transit by the trolley system, moving the workers to the suburban homes, is dividing the commercialism of cities from the homes, and in this separation of the shops and the mills from the dwellings of the people, the congestion is diminishing and refuting the apprehension of DeToqueville upon the hazard of American cities.

Electric transmission of power in separating the motor from propinquity to the source of energy, the waterfall or steam boiler, is abating the congestion of manufacturing.

The telephone in giving means for conference by facilities for the question and immediate answer is in like manner reducing the necessity of similar commercial interests keeping in close distances from each other. The natural trend of affairs has been concentrating population into cities, and the centrifugal force of electrical applications, while increasing the great commercial interests of cities, is also ameliorating those conditions in such manner that this concentration can continue without also imposing restricted conditions of life.

It is a fact in the history of banking that a fortune has never been made by any man who worked on the market against the credit of the United States Government; and in like manner it is true that no fortunes have been made on a policy which militated against the progress of invention.

The result of the inventor's work has increased the productive capacity of the individual and this gives a greater amount of resource to the consumer; this means a greater supply to the individual, or luxury in comparison with absolute personal necessities.

If you wish concrete illustrations, recall the stories of your grandparents and how they lived and what were the results; expenditures were limited and there was rarely enough of an accumulation from a life of labor and economy to provide for later years, when they were almost universally dependent upon succeeding generations for support.

Men are not now old at forty-five, be-

cause the services of the inventor have extended the potentiality of life over a longer scope.

The old proverb that "whoever is not rich, fat and handsome at forty will never be rich, fat and handsome," is not now true as to the first, for most fortunes are made after the dead line of forty years of age.

All hail to the inventor whose work has developed the socialism of brains which has made the prosperity which confers its benisons on all, even if its blessings may most notably appear upon a few.

NEW YORK STATE ELECTRICAL LABORATORY.

As has been mentioned in the ELECTRICAL REVIEW a number of times, a commission to consider the establishment of a state electrical laboratory for New York was appointed early last year. This consists of State Engineer Edwin A. Bond, Mr. Charles P. Steinmetz, electrical expert of the General Electric Company, and Mr. Harold W. Buck, electrical engineer for the Niagara Falls Power Company.

This commission has completed its report and recommends an appropriation of $275,000 for buildings and electrical equipment to be made to establish this laboratory in connection with Union College at Schenectady. Of this amount about $100,000 is intended for buildings and the remainder for the equipment. The establishment of this laboratory in connection with a college will enhance its value to the state very much, while at the same time the laboratory will benefit from connection with an already well established institution.

It is to be hoped that the state legislature will consider this matter at an early date and will reach a favorable decision. The necessity for an authoritative board, to which questions relating to electrical matters can be referred, is becoming more important every day. The work of this institution will in no way interfere with that of the National Bureau of Standards at Washington, as the latter will be devoted more to the purely scientific questions, while the state laboratory will deal with matters pertaining more to engineering and technical problems.

REPORT ON THE CHICAGO TRANSPORTATION PROBLEM.

The city of Chicago is to be congratulated that it was able to secure the services of so capable an engineer as Mr. Bion J. Arnold to report upon its transportation problem.

In this report are embodied the results of a most thorough and painstaking study of the present conditions and the means of improving them and relieving the congestion of traffic in the business section of the city.

One of the conclusions which Mr. Arnold reaches is that there should be but one fare paid for transportation between any two points in the city. It is shown that with proper protection of the companies against the dishonest use of transfers this can be done profitably. At the present time the city is divided into three sections, and a double fare is charged for transportation between any two sections.

Another point emphasized by Mr. Arnold is the interference with the cars caused by trucks and wagons. This is a common cause for complaint in all large cities, and some means should be devised for doing away with it. A wagon will drive deliberately along the track in front of a car and refuse to turn out until it reaches the cross street. Delays are frequently caused by wagons which back up to the curb to unload, leaving the front end projecting far enough out to prevent cars from passing. It is evident that the railroad company is not to blame for these troubles, and the city officials should see to it that proper regulations are enforced to do away with this nuisance.

It was not to be expected that but one plan would be suggested as a solution of the problem, and, as the report shows, Mr. Arnold suggests several. To handle the surface traffic from the outlying districts to the business centres subways are proposed under the business streets. These as planned, will be large enough to accommodate the standard double-truck cars now in use. For transferring passengers between railway stations and for local traffic in the business section electric surface roads are proposed. A remodeling of the Union loop is planned which will very materially increase the terminal facilities of the elevated lines. To give the roads entering the business section from the west side equally good terminal facilities, and yet to avoid grade crossings in the subways, a system of deep subways is proposed. These pass beneath the other system of subways, and above the Illinois Telephone and Telegraph Company's tunnels. At intersecting points with the other subway two-story stations are to be constructed. This system would enable passengers to transfer from trains coming from one section of the city to those of another, and yet would entirely prevent the dishonest use of transfers, as no one would be allowed to enter the subways without paying fares. This plan is suggested as the ideal solution of the problem, but naturally would be more expensive than other plans considered.

Entire rerouting of the surface lines is suggested, which will aid very materially in relieving the present conditions. It is also proposed at once to do away with all the cable roads, replacing them by electric conduit roads.

A very interesting section of the report is that which takes up the probable growth and income from these railways during the next fifty years. Statistics of the principal European and American cities have been studied. These show varying results, but by plotting the growth of the various cities and combining these curves, an ideal curve is obtained. The growth, as computed from this curve, is much less than that obtained by plotting the curve for the actual growth of Chicago for the past sixty years and extending this. It is thought, however, that these two curves represent the upper and lower limits between which the population will vary. From these curves an interesting law has been deduced, which shows that the rate of growth of a city goes on at a decreasing rate.

The estimated cost of the surface lines, if constructed new and everything first class throughout, would be $70,000,000. The cost of the preferred subway would be $20,000,000, making the total cost $90,000,000. The yearly gross receipts in car fare per capita for a city of 2,000,000 should be $10.60, as deduced from a study of this feature of railway operation in American cities. When the population reaches 4,000,000 the yearly gross receipts per capita should be $13, making the total gross receipts $20,600,000 and $52,000,000, respectively.

ELECTRICITY IN SHIPYARDS.

The great advantages of electrical transmission in shipyards have often been pointed out. In this issue of the ELECTRICAL REVIEW, we describe the plant of the New York Shipbuilding Company, at Camden, N. J., where electrical methods have been used to the fullest extent. It is noteworthy that in this plant induction motors have been used for machine-tool driving with marked success.

While all the machine tools and woodworking tools are here operated electrically, this part of the installation is by no means the most important. It is in the application to crane service that electricity here scores its greatest success. In this plant there are thirty-five electrically operated cranes covering the entire works, so that after the freight train bringing the raw material has entered the yard, there is no necessity for handling the material by hand. A large Gantry crane picks the material up from the car and carries it into the storage room, which extends past the ends of the various machine shops. Each of these shops has its system of cranes which pick the material up from the storage room and pass it through the shop.

Special types of cranes enable the material to be picked up in one bay and carried into another without handling by hand. Electromagnets are used for handling large plates and other material. Electric cranes serve the shipbuilding ways, so that from the time the material leaves the freight car until it leaves the works in the completed ship, it is always handled by an electric crane. A complete engine or boiler may be picked up in the machine shop and placed in a ship without rehandling. The electric crane has undoubtedly been one of the most important factors in our wonderful industrial development during the past ten years. Evidently its value was fully recognized by the engineer of this plant.

The other uses of electricity are not neglected in this model plant. Incandescent lighting systems are installed, as well as a complete telephone station, fire-alarm and clock systems.

THE MORSE DIARY.

In this issue we conclude the abstract of the Morse diary which was begun in the issue of January 10. It is to be regretted that we have not space in which to reprint all of the letters and reports contained in this interesting record of the earliest application of electricity to the use of man. In reviewing the work done by any great inventor one is more apt to dwell upon his successes than the difficulties encountered; but this record, kept during the actual progress of the work, shows the many disappointments and discouragements met with in this undertaking, and as one reads the letters his estimation of the first telegraph engineer grows larger.

Morse was undoubtedly possessed of the true prophetic inspiration, and his name must properly rank as one of the greatest in American history.

POLE LINES FOR POWER TRANSMISSION—II.

BY ALTON D. ADAMS.

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In some cases the poles of transmission lines are painted over their entire length. Pole tops should always be pointed or wedge-shaped, to shed water, and paint or tar should be applied to these tops. In some cases poles are filled with crude petroleum or other preservative compound in iron retorts, where moisture is withdrawn from the pole by exhausting the air, and then, after treatment with dry steam, the poles have the compound forced into them by hydraulic pressure.

In favorable soils cedar poles may remain fairly sound for twenty years, chestnut poles more than one-half of that time, and spruce and pine about five years. Poles up to forty feet in length may be readily set with pike poles, but when they are much longer than this a derrick will save time and labor. A derrick should have a little more than twice the length of the poles to be set.

Poles must be guyed or braced at all points where there are material changes in the direction of the line, and on long straight stretches about every fifth pole should be guyed or braced in both directions to prevent the poles setting back when the line wire is cut or broken at any point. Where there is room for wooden struts, as on a private right of way, they should be used instead of guys because of their more substantial character and the higher security of insulation thus obtained. Ordinary strain insulators can not be relied on with lines that operate at very high voltages, and where guys must be used, a timber four by six inches or larger, and ten to twenty feet long, should have the guy twisted about each end of it and be used as a strain insulator. A guy or strut should come well up under the lower cross-arm on a pole to avoid breaking of the pole at the point of attachment.

Where poles have heavy circuits and several cross-arms each it is sometimes desirable to attach a guy or strut beneath the lowest arm and also a guy close to the pole top. Galvanized iron or steel wire is the material best suited for guys, and the steel in cable form has greater strength and is more flexible than iron.

On the transmission line between Electra and San Francisco, which is intended to operate at 60,000 volts, the use of guys has been mostly avoided and struts employed instead. Where a guy had to be used, a strain insulator of wood six by six inches and twenty feet long was inserted in it.

The number and spacing of cross-arms on the poles of transmission lines are regulated by the number of circuits that each pole must carry and by the desired distance apart of the wires. Formerly it was common to carry two or more circuits on a single line of poles, but now the more general practice is to give each pole line only one circuit and each pole only one cross-arm, except that a small cross-arm for a telephone circuit is frequently placed some feet below the power wires. With only one transmission circuit per pole line, one wire is usually placed at the top of the pole and the other two wires at opposite ends of the single cross-arm. The older pole line for the transmission between Niagara Falls and Buffalo carried two cross-arms per pole for the power wires, these cross-arms being two feet apart. Each cross-arm was of yellow pine, twelve feet long, four by six inches in section, and intended to carry two three-wire circuits, making twelve wires of copper and 350,000 circular mils each per pole. On the later pole line for this same transmission each pole carries two cross-arms, the upper intended for four, and the lower cross-arm for two wires, so that one three-wire circuit may be strung on each side of the poles, two wires on the upper and one

on the lower arm in the form of an equilateral triangle. The pole lines between Cañon Ferry and Butte, Colgate and Oakland, and Electra and San Francisco all have only one cross-arm for power wires per pole, and the third wire of the circuit in each case is mounted at the top of the pole so that the three conductors are at the corners of an equilateral triangle.

This relative position of the conductors makes it easy to transpose them as often as desired. On the line from Cañon Ferry to Butte the cross-arms are each eight feet long with two holes for pins seventy-eight inches apart and are attached to the pole five feet ten and one-half inches from the top. Gains for cross-arms should be cut from one to two inches deep in poles before they are raised, and one hole for three-quarters or seven-eighths-inch bolt should be bored through the centre of the cross-arm and of the pole at the gain. Each cross-arm should be attached to the pole by a single bolt passing entirely through the pole and cross-arm with a washer about three inches in diameter under both the head and the nut of this bolt. One large through bolt weakens the pole and arm less than two smaller bolts or lag screws, and the arm can be more easily replaced if there is only one bolt to remove. Alternate poles in a line should have their cross-arms bolted on opposite sides, and at corners double arms should be used.

Yellow pine is a favorite wood for cross-arms though other varieties are also used. The large, long pins necessary on high-voltage lines tend to increase the sectional area of cross-arms, and a section less than five and one-half by four and one-half inches is seldom desirable. On the line between Electra and San Francisco, which carries the three aluminum cables of 471,034 circular mils each, the cross-arms of Oregon pine have a section of six by six inches each. Standard dimensions of some smaller cross-arms are four and one-quarter by three and one-quarter inches, and four and three-quarters by three and three-quarters inches, but it may be doubted whether these arms are strong enough for long transmission work. Cross-arms should be surfaced all over and crowned one-quarter to one-half inch on top so as to shed water. After being kiln dried cross-arms should be boiled in asphaltum or linseed oil to preserve the wood and give it higher insulating properties. Cross-arms longer than five feet should be secured by braces starting at the pole some distance below each arm and extending to points on the arm about half way between the pole and each end of the arm.

Each brace may be of flat iron bar about one and one-half by one-quarter inch in section, or the brace for both ends of an arm may be made of a single piece of angle iron bent into the proper shape. For high-voltage lines it is undesirable to employ iron braces of any sort since these braces form a path of low resistance that comes much too close to the pins on which the insulators and wires are mounted. Braces formed of hard wood are much better as to insulation, and such braces of maple are in use on the line between Butte and Cañon Ferry where the voltage is 50,000. Each brace on that line is thirty-six inches long and three inches wide, with one end bolted to the centre of its pole and the other end to the cross-arm twenty-three inches from the pole centre.

The line from Electra has hard-wood braces secured with wood pins.

Wood is the only material suitable for pins on which to mount the insulators of high-voltage transmission circuits. Iron has been used for pins, but it tends to grind and break the glass or porcelain of insulators and to offer too good a path between the insulator and the cross-arm. Oak and locust pins are most generally used, the latter being stronger and more lasting. In California pins of eucalyptus wood are much used and are said to be stronger than locust. All wooden pins should be boiled several hours in linseed oil after being well dried. This increases the insulating and lasting properties of the pins.

High-voltage lines require long pins to hold the lower edges of insulators well above the cross-arms, and these long pins must be much stronger than those used on ordinary lines, because of the increased leverage the wires have to break the long pins.

A pin twelve inches long over all and having a diameter of one and one-half inches in the part that enters the cross-arm has been much used for transmission circuits, but is much too short and weak for use with very high voltages. On the 50,000-volt line between Cañon Ferry and Butte the pins are seasoned oak boiled in paraffin. Each of these pins is seventeen and one-half inches long, two and one-half inches in diameter for a length of four and one-half inches in the middle part, two inches in diameter for a length of five and one-half inches that fits into the cross-arm or pole top, and one and one-half inches in diameter at the top of the thread inside of the insulator. These pins hold the outside edges of the insulators nine inches above the tops of cross-arms. Each of these pins is held in its socket by a three-eighths-inch bolt that passes entirely through the pin and the cross-arm or pole top.

On the line between Electra and San Francisco the pins are each sixteen and seven-eighths inches long, two and three-quarters inches in diameter at the largest central part, and two and one-quarter inches in diameter in the lower part, five inches long, that fits into the cross-arm or pole top. One of these pins broke at the shoulder with a pull of 2,200 pounds at the threaded part. Carriage bolts one-half inch in diameter pass through the cross-arms that carry these pins two inches from the top of the arm and one bolt three inches from the pin on each side. Without these bolts the arm split on test with a pull of 1,200 pounds at the pin, but with the bolts the pin broke as above.

The World's Consumption of Coal.

The general demand for coal has increased rapidly throughout the whole world, this being a characteristic feature of modern industrial development. The rapidity with which this increase has taken place may be appreciated when the present volume of production is considered. In 1901 the total coal production of the world was something over 866,000,000 short tons. In 1883 the world's production was only 450,000,000 metric tons. In 1872 the production was only one-third as much as it is at present, and in 1864 the world's production was 174,000,000 metric tons. During the last thirty years the combined coal output of the United States and the United Kingdom and Germany has averaged year for year about five-sixths the coal output of the world. In 1868 the United Kingdom produced three times as much as either the United States or Germany. The output of these countries is, approximately, 52 per cent, 14.5 per cent and 16.5 per cent, respectively, of the world's production. In 1870 the proportion was about the same, although the United States had gained upon Germany. In 1875 the output of these three countries was, respectively, 45, 20 and 18 per cent of the world's production. The production in this country increased continuously from that time until 1899, when it exceeded in quantity that of Great Britain. During 1901 the shares of the leading coal producing countries were as follows: United States, 34 per cent; United Kingdom, 28 per cent; Germany, 19.2 per cent.

THE DESIGNING OF TELEPHONE APPARATUS—XV.

BY W. A. TAYLOR.

Various kinds of material are used for points of contact between springs, some of which are very good and some very bad. Others work well in certain classes of work and fail in others. The old way was to bend down the end of the spring so the edge would bear as in A of Fig. 41. Sometimes to make the contact more secure the edge is serrated like a saw. This makes it more certain to cut through any dirt on the spring. In another form the metal is struck with a punch which makes the metal protrude on one side. As is shown by B in Fig. 41, C shows still a third form in which the contacts are riveted into the spring; one of these contacts is pointed and the other is flat. These contact points are formed from wire. In some cases each contact is formed up properly in a punch press before placing into the spring, while in other cases the wire is placed in properly cut lengths into the hole of the spring and then formed in proper shape. The latter method can not be used successfully, except where the spring is of fairly heavy stock. The formed contact is certainly the best contact by far. The arrangement shown by A and B, Fig. 41, works very nicely with simple boards for magneto work. Where the drop is thrown by means of a magneto generator the voltage is great enough to overcome any fairly high resistance in the contact. In addition to this it is seldom that the contact is broken when the current is passing, and for that reason there is no arc to be broken at the point of contact. These arcs turn the metal to a certain extent and form an oxide which generally is of high resistance. Hence, where a battery is used to signal and where such current is supposed to flow until the circuit is opened by the insertion of the plug, some metal which will not oxidize must be used if continuous service is to be desired. Many different alloys have been tried for these contact points, but pure platinum has always proved the best and the cheapest when considered from all points. The argument that platinum is too expensive is poor, as sales of goods wherein platinum is used can be made where other apparatus will not be considered. A customer who knows what he wants is always willing to pay the additional price required for platinum.

What is true for contacts which carry battery current is also true for contacts which carry the voice current. In Figs. 36, 37 and 38 the contacts do not carry the voice current, but in Fig. 39, where there are a number of contacts in series, a platinum contact is very essential, as a connection made at the extreme end will have all the contacts of the series to work through.

Recently a new alloy has been introduced which comes nearer to taking the place of platinum than anything on the market. The trade name of this alloy is "latinum." This alloy has a very high fusing point, and may be held in the flame of a Bunsen burner and heated to a white heat indefinitely without any apparent oxidization taking place. Neither sulphuric, hydrochloric nor nitric acid, when cold, has any noticeable effect upon it. This metal evidently has platinum in it, and probably contains iron, as it is magnetic. The magnetic part may, however, be nickel or cobalt. As this metal is not much more than one-half the weight of platinum and as its cost is only two-thirds as much it becomes a great temptation to use it instead of platinum. It remains to be seen how this metal will work in actual service.

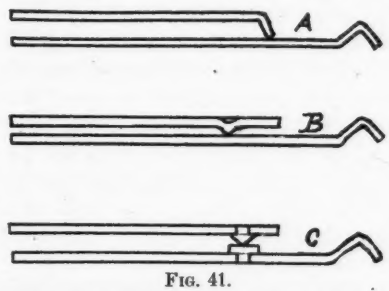


FIG. 41.

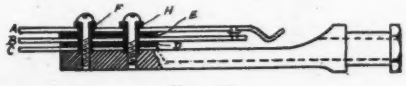


FIG. 42.

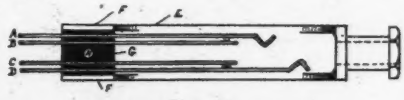


FIG. 43.

What shall be used to insulate the springs of the jack? Fibre and hard rubber are the materials used almost without exception. When the board is of the simple form, fibre is very good and has certain points which commend it, especially when the apparatus is to be handled by inexperienced help. Fibre is much tougher than rubber and will stand more abuse. Hard rubber alone should be used in insulating multiple switchboard jacks, as the circuits are so extensive and have so many connections in the jacks that if anything but the highest insulation is used trouble is apt to ensue. Fibre is inclined to be hygroscopic and on that account is bad where central energy systems are used. Where the fibre is damp the current is apt to start electrolytic action between the two springs or conductors, causing a complete breakdown. Where fibre is used for this purpose do not under any circumstances use the black variety without thoroughly testing the insulation. Certain makes of this color have been colored with lampblack, making it utterly unfit for electrical purposes.

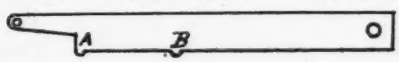


FIG. 44.

The common way for insulating the springs of jacks where the jacks are to be mounted individually is shown in Fig. 42. A and B are the two springs, C represents the body of the jack. Upon the rear end of the body or frame of the jack is a flat platform upon which the springs are mounted. D and E are the insulation pieces which separate the springs. F and H are insulation bushings which pass through all the springs and extend to the platform. The platform is countersunk a little in order to permit the ends of the bushing to enter when the springs are compressed by the screws which pass through the bushings. A metal washer the size of the flange on the bushing is placed on top of the bushing to receive the pressure from the screw-head. There is another way of mounting the springs which has been used to some extent, but not so extensively. The insulation is in the shape of a block, with slits cut for the springs, as shown in Fig. 44. A, B, C and D represent the springs, E is the frame, which has extensions, FF, extending up the two opposite sides of the insulating block, G. The springs are slipped down into the slits, which extend to within one-eighth of an inch from the bottom of the block. A piece of insulation is then placed over the springs, and then a stiff piece of metal is placed over this insulation. A screw then passes down through the hole, H, and screws into the metal frame. To prevent the springs from sliding lengthwise, small lugs, A and B (Fig. 44), are formed upon the edge of the spring. This form of jack is more expensive to make where individually mounted, but gives first-class service when made properly. This way of mounting is used in multiple boards, as well as in listening and ringing keys. In the multiple board, the jacks are made usually twenty in a strip, there being twenty jacks on one frame. When it is desired to examine such jacks the whole strip must be removed.

The Electrical Equipment of a Modern Shipyard.

THERE are probably few industrial plants which offer greater opportunities for the use of electrical power than a shipyard, and it is doubtful whether any plant has made better use of this power than has the New York Shipbuilding Company.

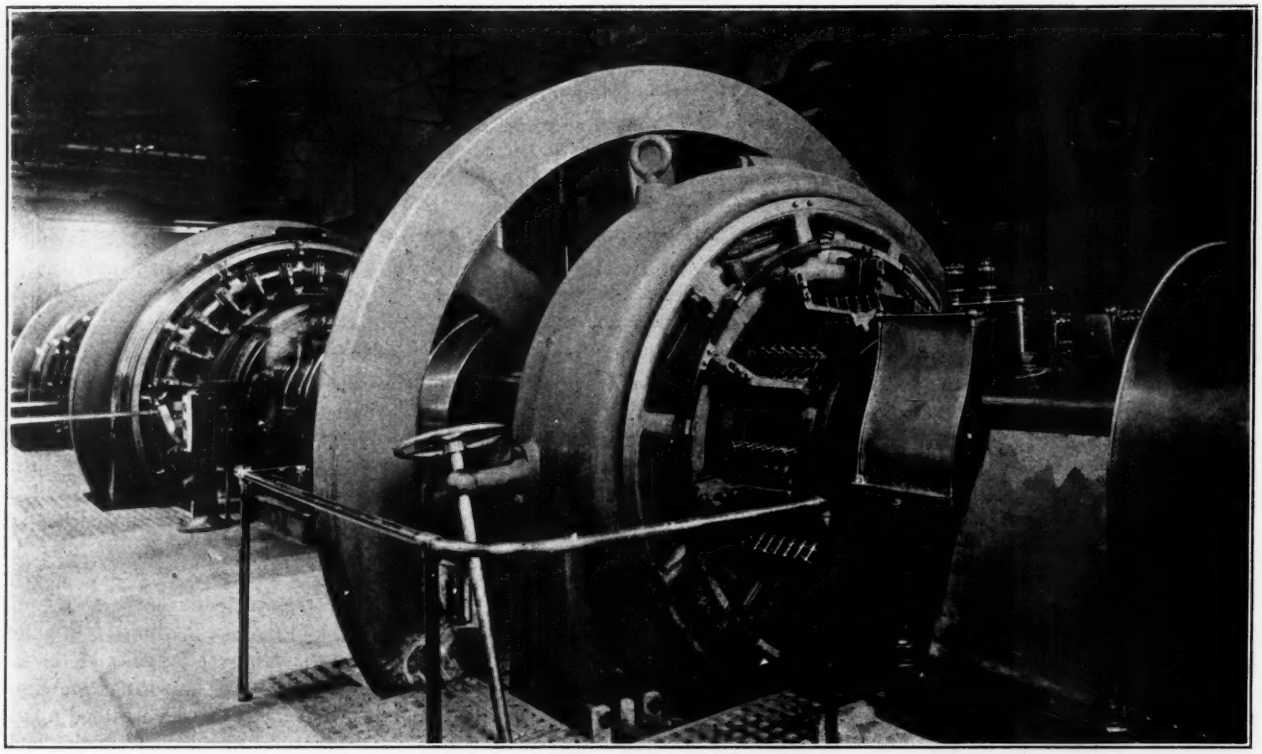
This company was organized by Mr. Henry G. Morse, to whom must be given the credit for the splendid establishment which has been erected by the company. Mr. Morse was engaged in bridge building until five or six years ago, when he went with the Harlan & Hollingsworth Company, of Wilmington, Del. He was with this well-known shipbuilding company for a number of years, and while there he realized the great opportunity which an entirely new shipyard offered for the introduction of modern tools and methods in shipbuilding. With this idea in view, he decided to organize a large company, and was so successful that the necessary capital was raised in a few months. It was decided to locate the new works on the Delaware, at Camden, N. J., and ground was broken there for a plant in July, 1899. Mr. Morse planned the entire layout of the plant, and even found time to design a number of noteworthy tools.

Realizing the many advantages presented by the electrical distribution of power in a shipbuilding plant, Professor W. L. Robb was retained as consulting engineer, and after a very careful study of the special problems presented by this undertaking a plant was installed which is in many ways unique.

The importance of this plant may be comprehended when it is known that the buildings contain eighteen acres of floor space. With the exception of the power plant and the joiner shop, which are kept separate on account of the fire risk, all the buildings are under one roof. The plant has a river frontage of 3,600 feet. The machine shop alone occupies four acres of ground space, and a storage house with a capacity of 20,000 tons of plates and shapes is provided. There are eight launching ways, each large enough to accommodate a ship 650 feet long. Four thousand men are employed in these works.

It is obvious that an adequate description of this large, modern plant can not be attempted here. In fact, the electrical features—to which it is desired to call particular attention—can not be fully described in the limited space at our disposal.

The boiler house contains a battery of Babcock & Wilcox water-tube boilers, fitted with the latest appliances. In the engine room are placed the pumps and air compressors for supplying water and compressed air throughout the works. The power plant consists of two 500-kilowatt, double-current Westinghouse generators, giving 240 volts direct potential on the direct-current side, and one 500-kilowatt Westinghouse direct-current generator giving the same potential. This last unit has but recently been added to the plant, while the first two units have been in operation for about two years. Double-current generators were installed because it was thought advisable to use induction motors for driving machine tools, while the many cranes could best be operated by direct-current motors. The selection of double-current generators then avoided the necessity of installing two plants for the different character of service demanded, and at the same time made the system more flexible, as each double-current machine may be called upon for its full capacity for either service. The two double-current generators are direct-connected machines and are operated in parallel on the alternating side. All three generators are run in parallel on the direct-current side. This arrangement then makes available 1,500 kilowatts, direct-current, at full load, or



VIEW IN POWER-HOUSE SHOWING THREE 500-KILOWATT DIRECT-CONNECTED GENERATORS, NEW YORK SHIPBUILDING COMPANY, CAMDEN, N. J.

1,000 kilowatts, alternating current, and over. This method of operating has given no trouble whatever, the machines dividing the load between them evenly. Indeed, when the alternating side of the two double-current generators is heavily loaded, the third machine helps out the alternating side by furnishing power to it through the two double-current generators as synchronous converters.

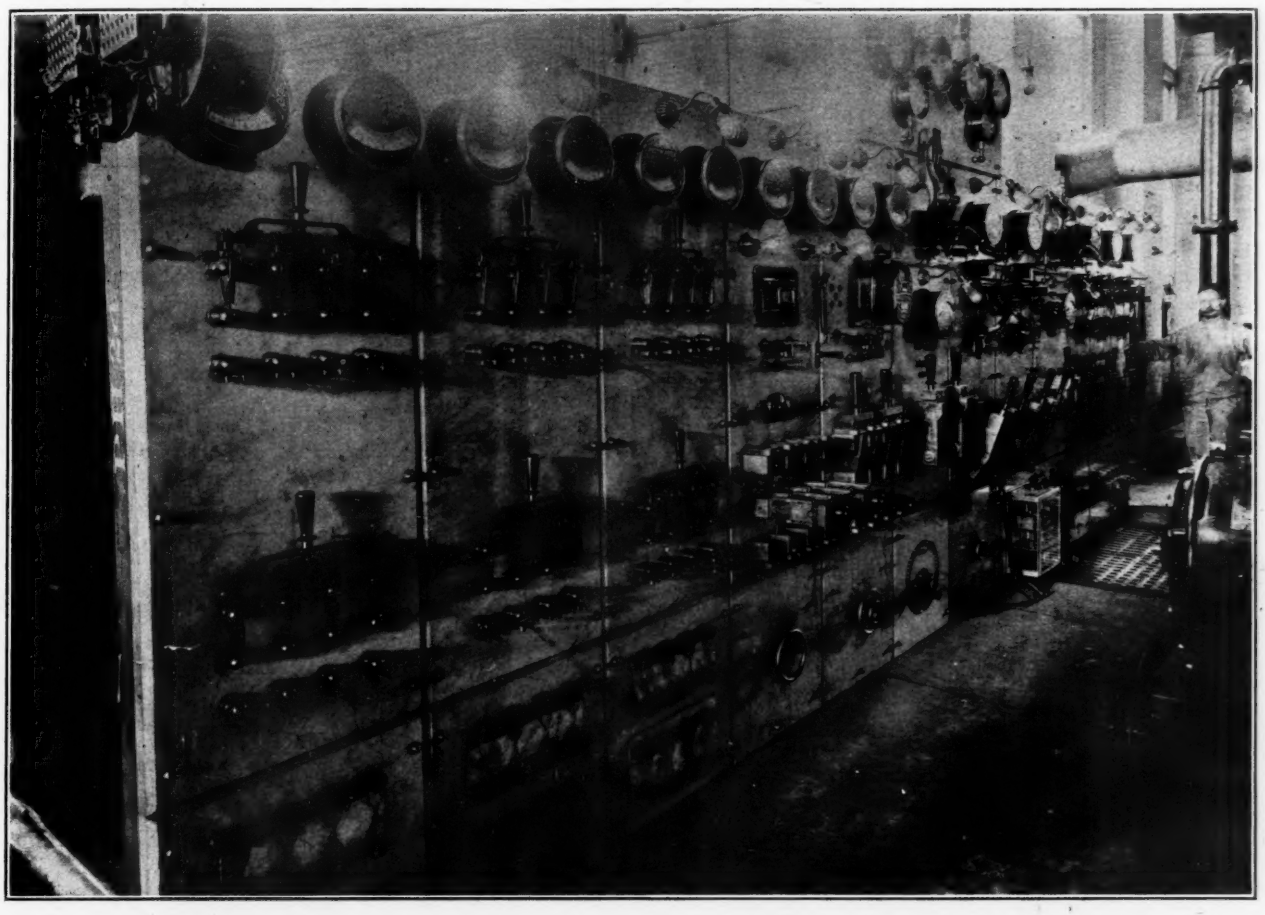
As it was decided to use 240 volts for direct-current distribution, the alternating-current pressure at the generators was lower than desirable for operating induction motors. Step-up single-coil transformers were therefore introduced between the generators and the switchboard, raising the potential from about 172 volts alternating current to about 210 volts.

The mains between the generators and the step-up transformers consist of three cables in parallel, each having a cross-section of 600,000 circular mils. Connection between the transformers and the switchboard is made by means of three cables in parallel, each having a cross-section of 500,000 circular mils. The mains from the direct-current side of the generators have a cross-section of 1,500,000 circular mils, and the equalizer—as the machines are compound-wound—has a cross-section of 1,000,000 circular mils. These cables are paper insulated and lead sheathed, and are laid in cement-lined iron pipes.

The generators are driven by three Rice & Sargent horizontal cross-compound engines, built by the Providence Engine Works. The cylinders are eighteen inches by thirty-six inches by forty-two inches stroke. They run at 120 revolutions, taking steam at 150 pounds pressure and developing 720 horse-power at one-quarter cutoff.

An exciting set, consisting of a fifty-kilowatt generator direct-connected to an eighty-five-horse-power Ames engine, running at 250 revolutions per minute, serves also for furnishing the night lighting. In addition to this there is another set consisting of a forty-horse-power induction motor driving a twenty-two and one-half-kilowatt, direct-current generator.

The switchboard consists of twelve panels and, as shown in the accompanying illustration, is fully equipped with all necessary accessories. Referring to this illustration, the three panels on the left are feeder panels for the alternating-current system. Next to these are two panels for the alternating-current side of the two double-current generators. The central panel controls the output of the direct-current machine, and the next two the direct-current ends of the double-current generators. The four remaining panels to the extreme right control the direct-current feeders. Fuses are supplied in the alternating-current feeders and circuit-breakers for the direct-current feeders. Recording wattmeters keep a record of the total output of both systems.

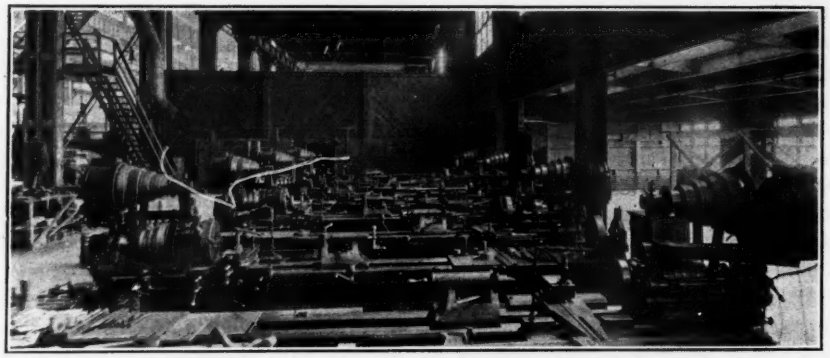


SWITCHBOARD FOR BOTH ALTERNATING AND CONTINUOUS-CURRENT SYSTEMS, NEW YORK SHIPBUILDING COMPANY, CAMDEN, N. J.

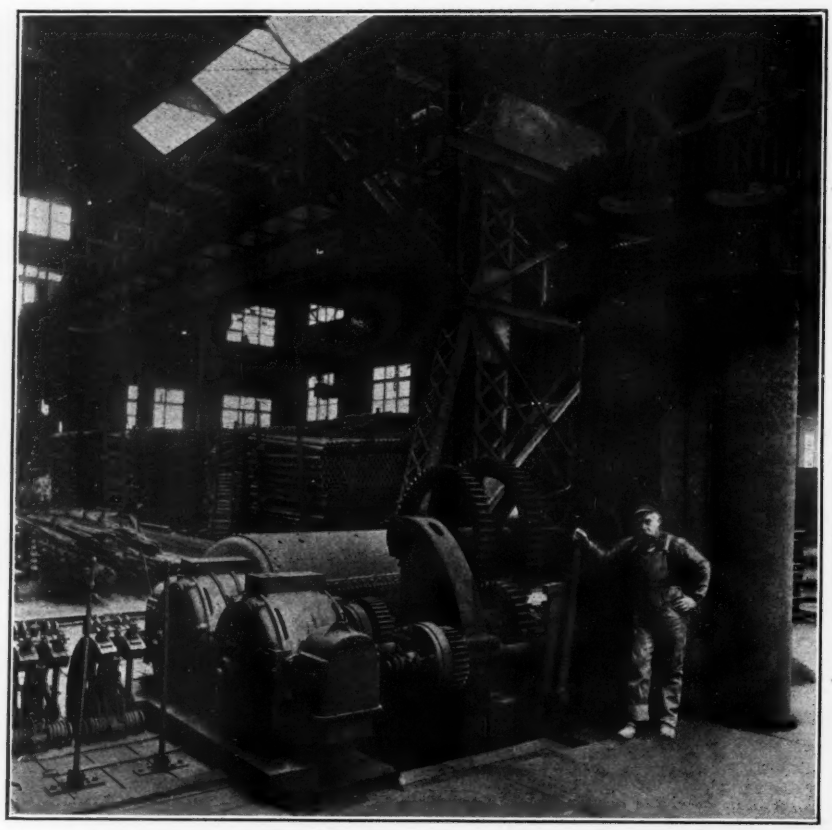
The feeders from the switchboard are four-conductor, paper-insulated, lead-sheathed cables, carried in cement-lined iron pipes. In all the shops weather-proof wire is used, and is carried on the girders. A four-conductor cable is carried to the joiner shop, which, as mentioned above, is separate from the main works. There are no fuses in the alter-

nating-current motor circuits, but fuses are placed in the direct-current motor circuits. The illustration gives a general view of the main bay of the machine shop and some idea of the size of these works. The stock is brought in at one end of the machine shop and is worked into shape in its passage through. This material is delivered by the yard railway, of which there are about six miles within the enclosure, but practically no tracks enter the buildings.

For handling the material an elaborate system of electrically operated cranes

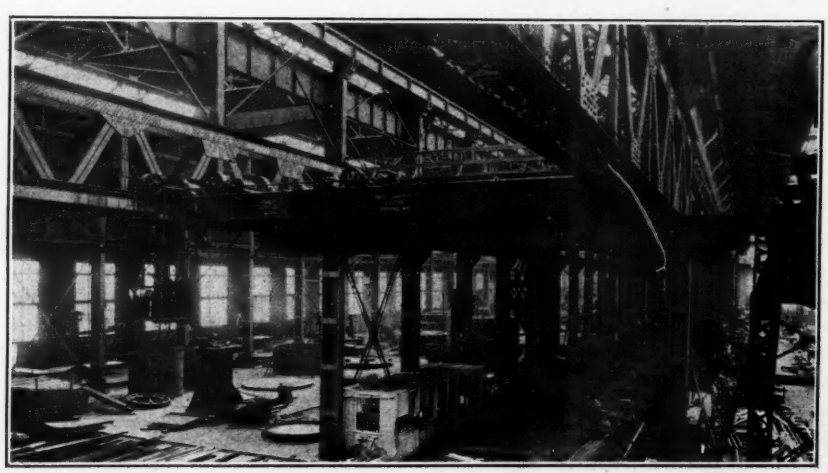


Motor-Driven Lathes, New York Shipbuilding Company, Camden, N. J.



Vertical Bending Rolls, Driven by Two 50 Horse-Power Motors, New York Shipbuilding Company, Camden, N. J.

was devised, which covers all departments and enables all material to be carried from point to point with a minimum expenditure of labor. For carrying the material into the building from the yards, a large Gantry crane was built. This traverses the entire length of the storage plate shed, crossing the end of the boiler, angle and plate shops, and passes out into the yard. This crane has a span of eighty-eight feet and a lift of twelve feet. It has two ten-ton trolleys, each provided with a twenty-five-horse-power street-car motor, and able to lift full load twenty feet a minute. Each trolley has a two-horse-power crane motor to move it along the bridge. The bridge itself is moved along the runway by two twenty-five-horse-power railway motors operated in series parallel. Current is supplied to these motors by overhead trolley in the yard, and in the buildings by a trolley wire on each side placed in V-shaped insulators near the ground and boxed over for protection. This crane is a feeder for the system of thirty-five electrical overhead traveling cranes in the shops ranging in lifting capacity from 5 to 100 tons. The motors operating these cranes aggregate 2,000 horse-power. The largest of the cranes has a capacity of 100 tons and a span of 121 feet. By means of a transfer table this crane can cover the machine shop, ways and slip, picking up a completed engine in the shop and placing it in the ship. This crane has two trolleys, each capable of lifting fifty tons at eight feet per minute, and each provided with a fifty-horse-power street-railway motor. The height of the lift is 115 feet. Each trolley is traversed in the bridge by a seven and one-half horse-power motor. The bridge is moved by two thirty-five-horse-power motors, provided with series-parallel control. Each of the smaller cranes has its own field operation. Some of these have interesting features. To enable material to be passed from bay to bay without handling by hand, certain of



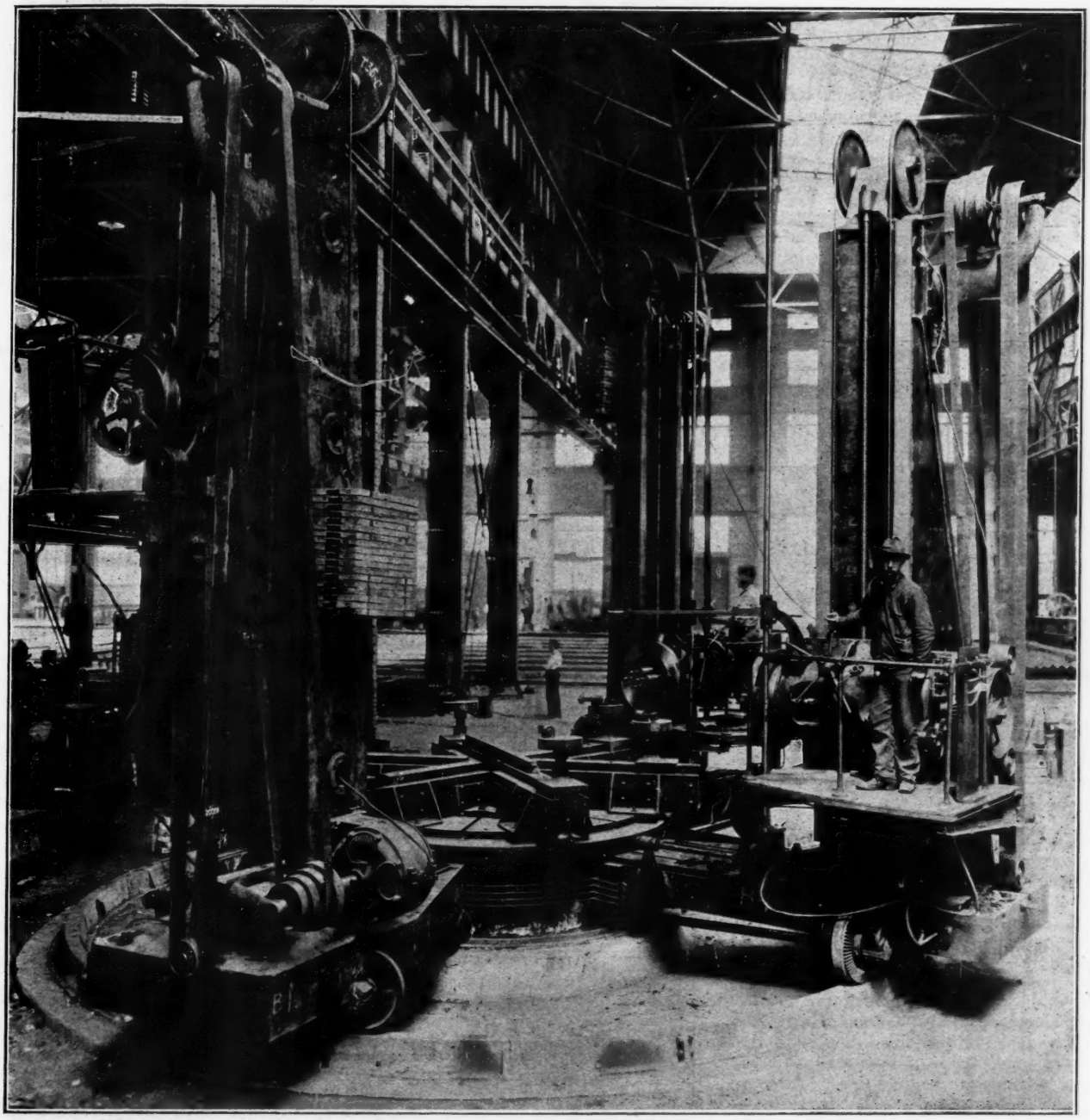
Extension Crane, New York Shipbuilding Company, Camden, N. J.

the cranes are provided with extension arms, which can be extended into the adjoining bays, enabling a crane to take up material lying in the adjoining bay and transfer it either to a point in its own bay or to the one on the other side. The extension arms are operated by the same motor which moves the crane and by a special arrangement of starting clutches. Longitudinal motion of the crane can not take place until the extension arm has been withdrawn under the crane proper. This prevents damage to the arm. In addition to the 100-ton crane, which can travel over the ship ways, each way has two ten-ton cranes whose operations are confined there. For handling plates in the shop a small Gantry crane is used.

Power is distributed to the cranes by overhead double trolleys. For the smaller Gantry a side contact rail near the floor, and covered over, is used. The arrangement of the large Gantry was described above. All these crane motors are operated by rheostatic control except the bridge motors, as explained.

For lifting large plates the cranes are equipped with powerful electromagnets controlled by the operator. Two of these are seen holding an eight-ton plate in the illustration of the large Gantry, while the illustration of the small Gantry shows a number of magnets of somewhat different type. These magnets have been found very useful and reliable, as they enable the operator, with one assistant, to do the work of ten or more men. The magnets will pick up a number of thin plates at a time, and can be made to drop these one at a time if so desired.

All the tools in the machine shop are driven electrically. The large tools have independent drive, and the smaller ones are grouped under short sections of shafting, each section being driven by a motor. Induction motors were used for this work because they were thought to be very reliable and little subject to damage or injury. The record of these motors shows that the engineers of the plant were not mistaken, as although there are 350 induction motors in use, varying in capacity from two to fifty horse-power, it is rare that one is laid up for repairs. Motors



MULTIPLE SPINDLE BOILER SHELL DRILLING MACHINE, NEW YORK SHIPBUILDING COMPANY, CAMDEN, N. J.

under fifty horse-power are started without the use of auto-starters, being thrown directly upon the circuit. As all the motors are driven electrically it is somewhat difficult to give an entirely satisfactory idea of the various uses to which they have been put. One of the illustrations shows a group of eight-inch lathes, motor-driven.

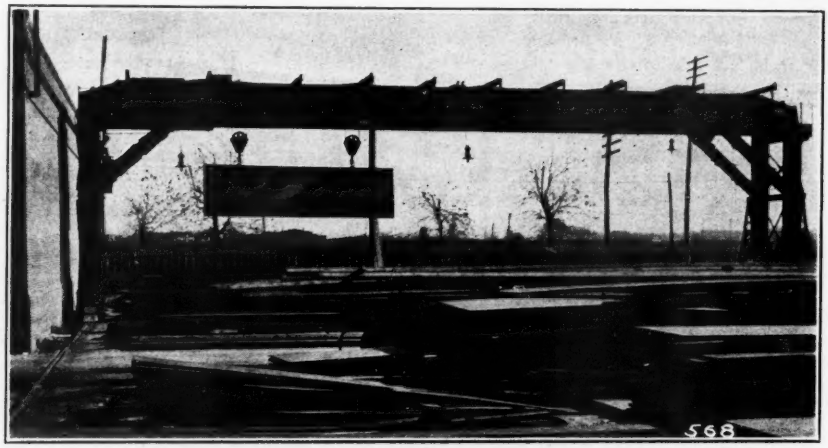
An important tool in every shipbuilding yard is the plate-bending roll. One of these is shown in the illustration. This is a large vertical roll driven by two motors of fifty horse-power each, and was built by Bement, Miles and Company.

One of the most striking tools in the boiler shop is the large multiple spindle boiler shell drilling machine shown in the illustration. This was built by the New York Shipbuilding Company for its own use, according to designs by Mr. Morse. It has three drill heads, each containing four spindles adjustable in all directions. Twelve holes can thus be drilled at the same time. A five-horse-power motor drives a 100-ton punch successfully, although work of this character is usually considered unsuitable for motor drive.

The tools of the joiner shop, with the exception of those of the smallest class, have all separate motor drive.

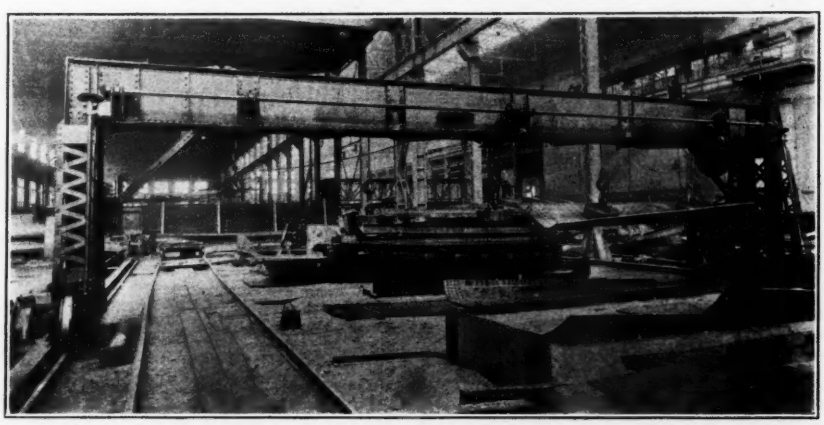
The shops are well lighted by enclosed arc and incandescent lamps. There are 700 General Electric enclosed arc lamps, operating at 230 volts on the direct-current circuits, as it was thought that this system would give better satisfaction than alternating current. In addition to the arc lamps there are 3,000 incandescent lamps in the works, connected to a 230-volt circuit. For portable lights cargo clusters are used, and have been found very satisfactory.

A very completely equipped repair shop is provided for all work of this character, as well as for making small parts. The company manufactures all fittings for marine work, and all electroplating is also done at the works.



LARGE GANTRY CRANE SUPPORTING EIGHT-TON PLATE BY MEANS OF MAGNETS, NEW YORK SHIPBUILDING COMPANY, CAMDEN, N. J.

MACHINE SHOP, NEW YORK SHIPBUILDING COMPANY, CAMDEN, N. J.



SMALL GANTRY CRANE, NEW YORK SHIPBUILDING COMPANY, CAMDEN, N. J.

The shops are heated by the Sturtevant system, using exhaust steam for heating the air, which is then distributed throughout the works.

A complete fire-alarm system, consisting of about thirty stations distributed throughout the plant, has been organized. Water is furnished to the fire hydrants by means of large pumps and a water tower.

A telephone system of ninety stations puts all parts of the works in close communication, and an excellent clock system shows the time at all points.

As already stated, the greatest part of the credit for this magnificent plant must be awarded to its organizer and active head, Mr. Henry G. Morse. With Mr. Morse are associated Mr. Myron C. Wick, vice-president; Mr. De Courcey May, general manager; Dr. Francis Elgar, consulting naval architect; Mr. Samuel M. Knox, secretary; Captain W. G. Randle, treasurer, and Mr. Charles S. Hall, superintendent of the hull department and purchasing agent.

Dr. Wm. Lispenard Robb, mentioned previously, still retains his position of consulting electrical engineer. Mr. L. C. Richards is head of the electrical department, which embodies both the land and marine installations, in which latter work he is assisted by Mr. H. A. Hornor.

RAILROAD CAR BRAKING—IV.

BY R. A. PARKE.

The investigation disclosed the fact that a structural feature of truck-brake gear that had been found to complicate the application of brake-shoe pressure to the wheels, might be so employed that it would serve almost entirely to recover this lost efficiency in braking. It is, in brief, the angularity of the hanger link, by which, if the brake shoes be applied upon the inner face of the wheel—that nearest the centre of the truck—and the hanger link supporting the brake shoe be inclined at a proper angle with the tangent to the wheel at the centre of the bearing surface of the brake shoe, the brake-shoe pressure is proportioned to the wheel pressure. This matter merits very careful consideration.

More as a matter of convenience than for any other apparent reason, it has generally been customary, in passenger-car construction, to suspend the brake shoes from the end timbers of the truck at the outer face of the wheels. It is true that the brake shoes are thus more accessible for renewals, but the arrangement is inconvenient in other respects, requiring the disconnection and often the removal of the brake beams to remove the wheels. The application of the brake shoes at the outer face of the wheels results in an upward thrust of the brake hangers, proportional to the brake-shoe friction, upon the end timbers at the rear end of the truck, and a corresponding downward drag upon that at the forward end. It has already been shown that the retardation of the car by the rail friction produces a rotative effect upon the truck, which is greatly augmented by this direct action of the brake-shoe friction through the hanger links, and the result is that a considerable rotation or tilting of the truck frame actually occurs, compressing the forward equalizing bar springs and relaxing those at the rear. The reaction or recoil of these springs is the cause of the frequently observed violent backward surge or shock, so disagreeable to passengers and sometimes throwing unguarded standing persons to the floor at the instant of stopping. If, however, the brake shoes were suspended at the inner face of the wheels the upward thrust of the hanger links would act upon the forward portion of the truck frame, and the downward thrust upon the rear portion, so that the effect would be to counteract and neutralize instead of aggravate the disagreeable influence of the rail friction.

Another and still more serious objection to this method of suspending the brake shoes is the evil effect of the angular inclination of the hanger links, which is not only desirable to ensure clearance of the shoes from the wheels when the brakes are released, but is usually unavoidable for constructive reasons. This feature will be better understood upon further consideration of the effect of inclining the brake beam hanger links.

Fig. 3 represents the outlines of the usual form of passenger car truck, in which are indicated by arrows the forces applied to each brake beam. These forces are not all in the same lateral plane, the actuating brake force P from the brake cylinder being at the centre of the brake beam, while one-half of each of the other three forces is applied to the brake shoe at each end of the beam; but it is simpler and without objection to treat them as represented. The forces Q_1 and Q_2 are the reacting pressures of the forward and rear pairs of wheels, respectively, upon the brake shoes; the forces F_1 and F_2 are the corresponding frictional forces resulting from the pressures Q_1 and Q_2; and the forces V_1 and V_2 are the reaction upon the brake shoes from the

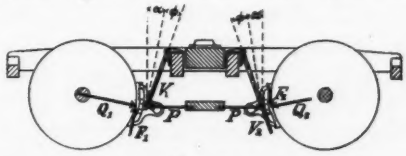


FIG. 3.

hanger links. The centre of the brake shoes should be about three inches below the centre of the wheels, and the angle between the radial direction of the pressures Q_1 and Q_2 and the horizontal, is designated by α. The mean frictional forces F_1 and F_2 consequently incline at the same angle with the vertical. The inclination of the hanger links to the tangential direction of the frictional forces F_1 and F_2 is designated by φ. The forces being resolved in rectangular components, with reference to the direction of the hanger links of each pair of wheels, the following relations are evident:

$$Q_1 \cos \varphi - F_1 \sin \varphi - P \cos (\alpha + \varphi) = 0$$
$$Q_2 \cos \varphi + F_2 \sin \varphi - P \cos (\alpha + \varphi) = 0$$

If the coefficient of brake-shoe friction be designated by f_2, then, whatever be its value, $F_1 = f_2 Q_1$ and $F_2 = f_2 Q_2$. Replacing Q_1 and Q_2 by their values, in terms of F_1 and F_2, these equations may be combined and solved for φ and P, with the results that

$$\tan \varphi = \frac{1}{f_2} \frac{F_1 - F_2}{F_1 + F_2} \qquad (3)$$

$$P = \frac{(F_2 + F_1) \cos \varphi - f_2 (F_1 - F_2) \sin \varphi}{2 f_2 \cos (\alpha + \varphi)} \qquad (4)$$

In retarding the motion of the vehicle, the friction of the brake shoes must resist rotation of the wheels to the same extent that the rail friction urges continued rotation; and, in addition, it must also destroy the rotative energy of the wheels. That is, the stored energy due to the rotary motion of the wheels, which is entirely independent of the energy due to the motion of translation (and which would still consume considerable work if the translation of the entire vehicle, wheels and all, could be overcome by means not affecting the rotation of the wheels), absorbs a part of the work done by the brake shoes and only what then remains of that work operates to excite rail resistance to wheel sliding. The peripheral velocity of the wheels being the same as the velocity of translation, if r_1 represents the radius of the wheel, a retardation p of the vehicle is accompanied by an angular retardation p/r_1 of the wheels' rotation. If, also, w represent the weight of each wheel and r_2 the radius of gyration, then when the rail friction produces the retardation of the motion of the car, the corresponding retardation of the rotary motion of the wheels requires at the surface of each wheel a retarding force equal to $w/g \cdot r_2^2/r_1^2 \cdot p$. By careful computation, the square of the radius of gyration of car wheels is found to be six-tenths of the square of the wheel radius. Therefore, the brake-shoe friction being required to supply both retarding forces, the relation between the wheel forces of the two pair of wheels is obviously

$$F_1 = \frac{1.2\, w}{g}\, p + T_1$$

$$F_2 = \frac{1.2\, w}{g}\, p + T_2$$

If now the maximum rail friction which may exist with the unequal distribution of weight upon the different pairs of wheels, as found in equations (1) and (2), is to be realized, it is necessary that the brake-shoe friction F_1 and F_2 shall correspond with those rail frictions. Giving T_1 and T_2 the values of equations (1) and (2), respectively, and giving p the value found for it, these brake-shoe frictions become

$$F_1 = \frac{f_1 W}{4} \frac{(W + 4.8\, w)\, b + 2 f_1 (W_1 h + 2 W_2 d)}{(W + 2 f_1 W_1 k/l)\, b}$$

$$F_2 = \frac{f_1 W}{4}$$

$$\frac{(W + 4.8\,w)\,b - 2\,f_1\,(W_1\,h + 2\,W_2\,d)}{(W + 2\,f_1\,W_1\,k/l)\,b}$$

Applying these values in equation (3), it becomes

$$\tan\varphi = 2\frac{f_1}{f_2}\,\frac{W_1\,h + 2\,W_2\,d}{(W + 4.8\,w)\,b} \qquad (5)$$

The expression for the braking force applied to the brake beam may be given a more convenient form for practical work by giving $F_1 - F_2$ the value $f_2\,(F_1 + F_2)$ tan φ, desired from equation (3), and, finally,

$$P = \frac{f_1}{f_2}\,\frac{W}{4}\,\frac{W + 4.8\,w}{W + 2\,f_1\,W_1\,k/l}\,\frac{(1 - f_2^2\tan^2\varphi)\cos\varphi}{\cos(a + \varphi)} \qquad (6)$$

Thus, by hanging the brake beams between the wheels, instead of outside, and inclining the hanger links at a proper angle, the increased pressure and consequently the increased friction of the brake shoes upon the forward pair of wheels and the diminished pressure and friction of the brake shoes upon the rear wheels, due to the effect of the friction itself in causing the shoes to press more or less forcibly upon the wheels through the angularity of the hanger links, are made to correspond with and compensate for the transferred weight from the rear to the forward wheels. In the same manner that running in the opposite direction causes a reversal of the conditions for the transfer of weight; so, too, the rotation of the wheels in the opposite direction causes a reversal of the effect of the inclined hanger links, and the increased brake-shoe pressure is always applied to the wheels carrying the increased weight.

It will now be more clearly understood why inclination of the hanger links of outside-hung brake beams has an evil effect upon the efficiency of the brakes. As the link must necessarily be so inclined, if inclined at all, that the upward movement of the wheel surface upon the brake shoe increases the brake-shoe pressure, the pressure is increased upon the rear pair and reduced upon the forward pair of wheels, when the brakes are outside-hung. Thus, the high brake-shoe pressure is always applied to the wheel carrying the reduced weight and the reduced brake-shoe pressure to the wheels carrying the increased weight. The braking force P upon the brake beam must, therefore, be so reduced that the rear pair of wheels shall not be caused to slide, and the combined friction of the brake shoes upon the two pair of wheels is thereby reduced accordingly. The loss of more than fifteen per cent in braking efficiency, which has been stated to result from the use of a uniform brake-shoe pressure instead of pressures proportioned to the rail pressures, occurs when the hanger links are not inclined, but it will now be understood that, with outside-hung brakes having the ordinary inclination of hanger links, the loss is considerably greater, the retardation probably averaging at least twenty per cent below that attainable by the expedient of inside-hung brakes with properly inclined hangers.

In practice, the application of this method of inclined hanger links is not without some difficulty. The chief trouble is that no constant angle of the links can be maintained, as the wearing away of the brake shoes, together with wearing and turning down of the tires of steel-tired wheels, causes constant and considerable variation. Thus, if the angle of inclination and the braking pressure be calculated for the conditions existing when the brake shoes and wheels are new, the increased angle when the shoes become much worn and the tires have been well turned off, would probably cause the forward wheels to slide upon the rails. On the other hand, if the calculations be made for turned wheels and worn shoes, the efficiency is too much reduced when the wheels and brake shoes are new. It is, therefore, necessary to compromise between the extremes, in reference to the angle of inclination of the hanger links. It is obvious that the variation of the angularity of the hanger links, through the allowance necessary for wear (two and three-quarters inches for steel-tired and one and three-quarters inches for chilled cast-iron wheels), is an inverse function of the length of the hanger link itself, which should therefore be as long as practicable. With the use of that form of brake-shoe holder or head in which the hanger link pin is located behind the centre of the brake shoe (illustrated in Figs. 2 and 3, above), the maximum length of hanger is secured. The form of brake head in which the pin is considerably above the centre, shortens the hanger materially, and its use should be avoided.

Whether the maximum rail frictions are developed by corresponding brake-shoe frictions or not it is to be observed that the relation between the frictions F_1 and F_2 expressed in equation (3) is one that always exists, being dependent simply upon the angle of inclination of the hanger links and the coefficient of brake-shoe friction and independent of everything else. Therefore, even though the angle of inclination varies with wear, and the construction of the truck may be such that the full inclination of the hanger, necessary to the greatest efficiency, can not be employed, a portion of the added efficiency of the system may still be realized by inclining the hanger links as much as may be consistent with proper length and the limitations of the truck construction, and by employing a corresponding brake-beam force. Although that component of the brake-beam force which is normal to the wheel surface decreases as the angle of inclination of the hanger increases, and is therefore more effective when the brake shoe and wheel are new than when they become much worn, the increased effect of increasing the angle of inclination of the hanger in augmenting the friction of the forward wheels slightly more than compensates for it; and it thus occurs that, if the brake-beam force is so regulated that the forward pair of wheels is not caused to slide upon the rails after both the brake shoes and wheels have become fully worn, they will not be caused to slide as either forward or rear wheels at any other time. The problem thus resolves itself into so laying out the truck brake gear that the centre of the half-worn brake shoe shall be at the proper distance (three and one-half inches) below the centre of the half-worn wheel, and that the hanger link (as long as possible) shall stand at as great an angle to the wheel tangent as possible, not exceeding the angle of full compensation, where it has the value found from equation (5)—when the brake shoe and wheels are each half worn—and then calculating the brake-beam force P for the angles φ_1 and a_1 that exist when the brake shoes and wheels are fully worn. To facilitate the application of the principle of inclined hanger links, the various angles of inclination for half-worn brake shoes and wheels, and the corresponding braking forces have been determined for different conditions, as to truck wheel base and diameter of wheel, and are tabulated below.

It will be observed in equation (5) that the angle of inclination of the hanger links varies inversely with the wheel base of the truck, which is fortunate, since long wheel base is desirable also in all other respects (ease of riding, minimum wear and tear of the wheel flanges and truck frames, etc.), except in cases where curves are so sharp that long wheel base interferes with curving. The full compensating inclination of hangers may be employed for any size of wheel, where trucks have a wheel base of eight

feet; and, for wheels of thirty-three and thirty-six inches diameter, it may also generally be employed where the wheel base is seven and one-half feet. With passenger-car trucks of ordinary construction, partial compensation may be obtained, for wheels of larger diameter than thirty-six inches, where the wheel base is seven and one-half feet, and, for thirty-three and thirty-six-inch wheels, it may also be obtained where the wheel base is but seven feet. Shorter wheel base than seven feet, while requiring a large angle of inclination of hanger links, provides insufficient room for an inclination of any value, unless the hanger links are so short that the variation of the angle destroys its utility, or the trucks are low, so that the height h is also reduced as the wheel base b is reduced.

The method of applying the principle, in cases where the full compensating angle of inclination can not be used, depends primarily upon the relations expressed in equation (3). As the braking force must be so established that the forward pair of wheels shall not slide when the wheels and brake shoes are fully worn, the friction of the brake shoes upon that pair of wheels must correspond with the rail pressure at that time, and the friction of the brake shoe upon the rear pair of wheels will necessarily be

$$F_2 = \frac{1 - f_2 \tan \varphi_1}{1 + f_2 \tan \varphi_1} F_1$$

as found from equation (3), in which φ_1 is the value of the angle of inclination of the hanger link to the wheel tangent when the brake shoes and wheels are fully worn. It has been shown that

$$F_1 = T_1 + \frac{2.4\ w}{W} (T_1 + T_2)$$

and that

$$F_2 = T_2 + \frac{2.4\ w}{W} (T_1 + T_2)$$

and, by combining these two equations,

$$T_1 + T_2 = \frac{W}{W + 4.8\ w} (F_1 + F_2)$$

and

$$T_1 = \frac{(W + 2.4\ w)\ F_1 - 2.4\ w\ F_2}{W + 4.8\ w}$$

The rail pressure, for the forward pair of wheels, was found to be

$$R_1 = \frac{W}{4} + \left\{ \frac{W_1}{W} \left(\frac{h}{b} - \frac{k}{l} \right) + \frac{2\,W_2}{W} \frac{d}{b} \right\} (T_1 + T_2)$$

If the full rail friction of this pair of wheels be utilized, $R_1 = T_1/f_1$ and the above values of T_1 and $T_1 + T_2$ being substituted in this equation for the rail pressure, it may be solved, with the aid of the above value of F_2 in terms of F_1 and $\tan \varphi_1$, to yield values of F_1 and F_2, which depend simply upon the available rail pressure of the forward pair of wheels when the brake shoes and wheels are fully worn. These values of F_1 and F_2 being then applied in equation (4) and representing the value of the angle α when the wheels and brake shoes are fully worn by α_1 the necessary braking force to be applied at each brake beam becomes

$$P = \frac{f_1}{f_2} \frac{(W + 4.8\ w)\ (1 - f_2^2 \tan^2 \varphi_1) \cos \varphi_1}{[W - 2 f_1 [W_1 (\frac{h}{b} - \frac{k}{l}) + 2\,W_2 \frac{d}{b}] + f_2 (W + 4.8\ w) \tan \varphi_1] \cos (\alpha_1 + \varphi_1)} W \quad (4)$$

In practice, the application of this brake-beam force by the air pressure in the brake cylinder is through the medium of a series of levers and connecting rods, pinned together and forming the "brake gear." A portion of the air pressure upon the piston of the brake cylinder is absorbed by the frictional rigidity of the brake gear; and, as the leverage of the brake gear is always calculated from the piston pressure, it is necessary to make proper allowance for the frictional loss in the brake gear. The only available results of investigation of such loss indicate that, in the ordinary form of passenger-car brake gear, the brake-beam force is about eighty per cent of that calculated from the piston pressure. As the total braking force of the car is the sum of the forces upon the four brake beams, if the calculated braking force of the car be represented by B, it therefore becomes $B = 4\ P/0.80$.

Examination of the practice in passenger-car construction of ordinary American steam railroads indicates quite general uniformity in respect to most of the various features which determine the angle of inclination of the brake hanger link and the braking force. In general, for practical purposes, the average of the conditions existing is sufficiently accurate and may be taken as follows: The coefficient of rail friction may be regarded as $f_1 = 0.25$, particularly as the limiting conditions are those of emergency applications. The coefficient of brake-shoe friction most apt to slide wheels is that of low speeds, near the end of the stop, and experience indicates a safe value to be $f_2 = \frac{1}{4}$. Little error will, in any ordinary case, result from making $W_1 = \frac{1}{3}\,W$ and $W_2 = 1/6\ W$. Generally, $h = 34$ inches, and $k/l = 1/15$. The height of the centre of gravity of the truck varies with the diameter of the wheels; for 33-inch wheels, $d = 20$ inches; for 36-inch wheels, $d = 20.5$; for 38-inch wheels, $d = 21$; for 40-inch wheels, $d = 21.25$; and for 42-inch wheels, $d = 21.5$; the weights of wheels differ both with the diameter and the construction; a fair average appears to make $4.8\ w = 0.071$ W for 33-inch steel-tired wheels, 0.080 W for 36-inch, 0.089 W for 38-inch, 0.094 W for 40-inch, and 0.098 W for 42-inch. With these values (except those depending upon the diameter of the wheels), the maximum braking force, as ordinarily calculated, which may be used without injurious wheel sliding, becomes

$$B = \frac{15\ (1 + 4.8\ w/W)\ (1 - 1/g \tan^2 \varphi_1) \cos \varphi_1}{16 \left\{ \frac{46}{45} - \frac{68 + d}{6\,b} + \frac{1}{3} \frac{(1 + 4.8\ w)}{W} \tan \varphi_1 \right\} \cos (\alpha_1 + \varphi_1)} W$$

For convenience in applying this principle to the design of truck-brake gear, the following table has been prepared, showing the angle of compensation which the hanger link makes with the vertical—that is $\alpha + \varphi$—instead of the angle φ with the tangent to the wheel, when the brake shoe and wheel are half worn. The angle is determined by placing the centre of the half-worn shoe (assumed to be when the thickness has been reduced one-half inch), three and one-half inches below the centre of the half-worn wheel the radius of which is assumed to have been reduced seven-eighths of an inch. For convenience, also, the tangent of the angle $\alpha + \varphi$ is given, so that a convenient definite distance having been laid off from the centre of the lower hanger link pin upon the vertical line through it, a horizontal distance from its upper end, equal to the product of this tangent and the vertical distance, will determine a point in the hanger link, and consequently its direction. The upper end will, of course, be fixed by the position in which the upper pin can be supported by a bracket from the truck transom, the length, however, being as great as possible. The braking force B is also given, as determined from the angles α_1 and φ_1 when the brake shoe has been reduced one inch in thickness and the radius of the wheel has been reduced one and three-quarters inches. As already stated, only partially compensating angles of inclination occur for a wheel base of eighty-four inches and, with thirty-eight, forty and forty-two-inch wheels, for a wheel base of ninety inches. In the other cases, full compensation occurs.

(To be concluded.)

An Interesting Journal of Samuel F. B. Morse, 1843-1848.

(Concluded.)

THE series of letters which was presented in last week's issue of the ELECTRICAL REVIEW is concluded in the following instalment. As explained last week, these letters form a part of a diary kept by Samuel F. B. Morse, and are a reliable and accurate record of the early history of the telegraphic line between Baltimore and Washington.

August 29th, 1843

Sir

I have the honor to report that the experiments recently made upon my Telegraphic wire have demonstrated the necessity of a greater quantity of wire in the formation of coils for the larger magnets, of which there are six to each coil, consuming in its construction one mile of wire. To each magnet there are two coils, consequently each magnet requires two miles of wire. I have already one magnet complete, but for my five remaining magnets I require 10 miles or 700 lbs of wire, the procuring which at 34 cents per lb. or an aggregate of $238, I submit for the approbation of the Honb. Secretary.

I would also further report that my wire in quantity about two miles was injured by the late unusual rain storm, the water filling the basement in which my lead pipe is in process of manufacture to the ceiling, delaying my operations for a week or ten days. My damage otherwise is trifling and can be made whole at an expense of within twenty dollars. . . .

I have the honor to be, &c.

To Hon. J. C. Spencer, S F B Morse
Secy of the Treasury.

Dear Sir

I have been daily expecting to hear from you and to be called on for the draft authorised in my last letter, But I write now in some perplexity. I fear a failure in regard to time on the part of the contractor for the pipe. It will be three weeks next Tuesday since the wire ready for the pipes was delivered at his factory, and by the terms of the contract he was to deliver to me "19,000 yards of pipe in thirteen working days thereafter" and not *one foot* is as yet ready. One weeks delay I allow for the damage and confusion occasioned by the flood. There is no intrinsic difficulty in the making of the pipe or of the introduction of the wire into it as it is made according to my plan. But it seems to me that a sufficient force of operatives is wanting, and a yankee contriving go ahead management is very much needed. I think the difficulties in the operation of carting and manufacturing are now overcome, but I am beginning to have my doubts whether the Contractor can retrive his lost time, or fulfill his contract in its spirit, to the letter he cannot. I wish therefore to know how long a delay is practicable on the part of Mr. Bartlett, and in case my fears should be realized in regard to the pipe whether the Month of Nov'r will be a good and sufficient time for the completion of his operations, and in case of *necessity only* whether it will be any inconvenience to him to postpone the trenching operations until then. If the pipe can be got ready, I should wish the trenching to commence earlier, by the middle of Oct'r as you desired in your last letter. But if not I should wish a delay to suit the exigency. I will apprise you in a few days of the prospects. I now write rather to advise you in time of an apprehended difficulty, so that no damage may accrue to Mr. Bartlett. I try to think that my fears are not well grounded. Other matters go on well.

Your Y freind & Ser
S F B Morse.

F. O. J. Smith, Esq.,
Portland, Maine.
Sept'er 1, 1843, New York.

New York, Oct. 28th, 1843

Sir

I have the honor to report that after every indulgence as to time, consistent with my paramont duties to the Gov't which I could extend to Mr. Serrell the Contractor for the lead pipe for the Telegraphs he is unable to supply in season little more than one fourth part of the pipe contracted for, I have taken the necessary steps for having the deficiency of some 25 to 30 miles supplied from another source if practicable. By resorting to another process of manufacture, and of insertion of the wire into the pipe, a less diameter of bore is necessary so that although the price of lead in the market since the date of Serrells contract has risen about 50 cents per hundred pounds, I am confident of being able to avoid any loss to the Gov'nt for the delinquency of Mr. Serrell, other than loss of time in the progres of the experiment from the season of the year, into which the delay has driven me. Under these circumstances, as Mr. Serrell has manifestly exerted his whole ability to discharge his contract in good faith, his delinquency having been occasioned by accidents. I am desirous of being authorised to supply the remainder of the pipe contemplated in the Contract without further dependence upon him provided it can be supplied without an increased cost to the Government, beyond the aggregate amount contemplated in Serrell's contract.

I would improve this occasion to announce to the Department the commencement of the trenching at Balt. on the line of the R Road to Wash'n and the laying down of the conductors. The work was commenced on Saturday Oct. 21st 1843 and 8 o'clock A M.

With the highest respect
Y Mo Ob Sert
Supt of the
Elec Mag Tel

To the Hon. John C. Spencer
Sec'y of the Treasury.

Copy of Instructions to Profr L. D. Gale
Assistant Super. &c
New York Nov 9th 1843

Sir

You will remain in superintendance of matters at Mr. Serrells until, the pipe which he can complete by the 16th inst. shall be finished, approved and delivered on board the packet for Baltimore. Whatever remains of wire in pipe unsoldered or on reels, have it wound up and proper care

New York August 10th 1843

Sir

I have the honor to transmit herewith my fifth monthly report of expenditures under the act of the late Congress for testing the practicability of establishing a system of Elec Mag Telegraphs for the United States.

I also take this opportunity of communicating to the Hon^ble Secy the result of the experiment made on the 8th inst with the prepared wire in one continuous line of 160 miles. Professors Renwick, Draper, Ellet & Schaffer, were present by invitation. Professors Silliman Henry, Torrey & Dr Chilton and other Gentlemen were also invited, but were prevented by official duties from attending.

FIG. 1.—FAC-SIMILE OF MORSE LETTER OF 1843, REPRINTED FROM HIS DIARY—FIRST PART.

taken of it, and have it delivered (taking receipts of the same) to Messrs. Tathams, placing it in charge of Prof. Fisher. See that all the property of the Government at Mr. Serrells, such as tools, spare reels, &c. if not required at Tathams is collected together and returned to my office in Nassau St., to be stored safely away. Keep B. F. Taylor with you to assist in your operations until you leave Mr. Serrells. Then give him the means $9.00 travelling expenses to go to Baltimore and report himself to Mr. F. O. J. Smith or to me. When Mr. Battin is done at Mr. Serrells give him also $9.00 for his travelling expenses and let him go to Baltimore and report himself to F. O. J. Smith. After all is finished at Serrells assist at Tatham's with Dr. Fisher to expedite the proving of the pipe. See my instructions to him respecting the operations there. After the 20th inst. or after every thing is completed at Tatham's, give Chase $9.00 to pay travelling expenses to Baltimore and let him go on and report himself there to F. O. J. Smith or to me. You and Dr. Fisher will then follow to Baltimore, your travelling expenses at the rate of 10 cents per mile will be paid by the Govnt.

Respectfully Y Mo Obt sert

Prof. L. D. Gale S. F. B. Morse

Then follows a letter to T. W. McCullock, and two to the Secretary of the Treasury, the latest bearing the date, "December 27, 1843." A fourth letter to the Secretary of the Treasury, dated "March 20, 1844," closes this section of the journal, and the second begins as explained above. From this we quote the following:

Saturday April 22d 1848

Left again for N. York in morning boat to meet Mr. Bain who I learned was in the city, arrived at 5 o'clock at Astor house found him there and had much conversation with him. He was naturally disposed to think more of his telegraphic mode than its intrinsic merits deserve. Ingenious as it is, it is attended with disadvantages to which mine is not subject, and mine has many advantages which do not belong to his mode.- In speaking of the *Alphabetic characters of lines and dots* I reminded him that they were mine which he used, and that they were patented in this country. He told me that they were not mine but a Mr. Swaim's of Phila. and referred me to the Amer. Museum where I would find the same thing. At this I was surprised and took the earliest opportunity to go over to the Museum and examine into the matter. Found a sort of Telegraph made of two stations of two buttons, one of which was made to show a dot, and the other a *perpendicular* line, but at each of the stations was Mr. Swaim's book, and also my alphabet; Mr. Swaims book is entitled the "*Mural Diagraph*" and as its name plainly indicates is intended and only intended to communicate by sound *through a Wall*. It was intended as he says that invalids or prisoners might have a means of communicating with one another through the wall. A knock meant |: two knocks 2 &c and a knock and a scratch on the wall meant something else. In order to describe this knocking & scratching on the wall, Mr. Swaim represents in his book one knock by a dot thus (.) two knocks by two dots (..) & so on, his scratch is represented by a *perpendicular* line, and these are the *dots & scratches*, which it is pretended are the same with my dots and dashes or lines composing my Telegraphic Alphabet. They are not the same, nor are they intended or adapted to the same purpose. Mr. Swaims combination could not be used in the telegraph and even if I had met with them previous to my invention of my Alphabet, an *essential* and *radical* change is necessary before they could be used for my purpose. Swaims *dots* are used by him to describe sounds of a particular kind, to wit a *blow* on the wall, his *scratch* is used also to describe a particular kind of a sound, and, in describing it, he represents the scratch by a perpendicular not a horizontal line. A *knock* & a *scratch* are represented thus, . | when written down, by the person the other side of the wall, he then may learn they are intended for a letter. Now my Telegraphic Alphabet is composed of *dots & dashes* or *horizontal* lines, without which *horizontal* character dots and lines are useless in the Electric Telegraph. Is not here an essential and controlling difference? The one kind cannot be used in the Telegraph, that is, the combination of *the dot & perpendicular* line, but the other kind is essential to use in the Telegraph, that is, the combination of *dots and horizontal lines.*- Swaim's were never intended to be written down beyond a *few feet;* not out of hearing of the voice of the person who knocks or scratches on the wall; for a *scratch* on the wall cannot be heard even at the limited distance at which a *knock on a wall* can be heard. While my combination of dots & dashes were intended to be written, thousands of miles distant, and are especially devised for that end and perfectly adapted to it.- I did not invent the *dot*, nor did I invent the *line;* nor did I invent the combination of dots and perpendicular lines, but I did invent the combination of *dots* and *horizontal* lines for the specific purpose of an Alphabet and applied and appropriated, this combination to imprint characters at a distance by electricity previous to any other person, even if they were like Swaims exactly, I content that my patent is good for applying them to a use never before employed.

Thursday Ap. 27 1848

My birthday 57. Mr. Kendall came up with me and passed the night. We return again this evening. Wrote Mr. Walker, Utica and enclosed three notes of Pomeroy & Walker &c for $500.00 ($500.00) and $1000.00. Sent to Post Office by Charles.

Some careful experiments on the decomposing power at various distances were made from which the law of propulsion has been deduced, verifying the results of Ohm and those which I made the summer of 1842 and alluded to in my letter to the Hon C J Ferris published in the House Report № 17. of the last Congress.

The practical influence from this law is that a Telegraphic communication on my plan may with certainty be established across the Atlantic! Startling as this may seem now, the time will come when this project will be realised. The wire is now in its last process of preparation for enclosing in the lead pipe, which will be commenced on Tuesday the 15th inst

I have the honor to be with

Hon John C Spencer Sincere respect

Sec'y of Treasury. Your Obt Ser

S F B Morse

Sup't of Elec Mag Tel

FIG. 2.—FAC-SIMILE MORSE LETTER OF AUGUST 10, 1843—CONCLUDING PART CONTAINING PROPHECY OF OCEAN TELEGRAPHY.

The American Association for the Advancement of Science—Convocation Week in the National Capital.

By George C. Maynard.

THE plan of holding the fifty-second annual meeting in mid-winter, and in Washington, proved very successful. An unusually large number of members from the different states and Canada was present, and the Washington contingent turned out in force. Of the 972 members registered, 351 were residents of Washington. The District of Columbia is full of scientists, and when they are aroused science begins to "hum." Many of these are known the world over as being among the most learned in their respective professions, and they are constantly engaged, either in government service or in a private capacity, in pursuing scientific investigations, the results of which they are always prepared to give. To this fact is largely due the success of the meeting. Every known "ology" was represented, and some newly invented ones were promulgated. The topics presented and discussed covered a broad range, from "the light of the stars" to "the vasomotor influence of the third cervical nerve upon the circulation in the rabbit's ear." The great discoveries and epoch-making advances of the year, having already been made public, called for little attention. The discussions were confined mainly to the relatively smaller things which, together, mark the general advance of scientific knowledge.

The business affairs of the association and the entertainment of the visitors were managed by a number of appropriate committees under the direction of Dr. Charles D. Walcott, director of the geological survey.

The addresses of the retiring president, Professor Asaph Hall, the eminent astronomer, and of the new president, Professor Ira Remsen, the equally distinguished chemist, related principally to the respective specialties of these gentlemen and were masterpieces. Professor Hall gave a brief and clear sketch of the history of astronomy, from the earliest times, with an eloquent prophecy of its great development in the future. He said that not only astronomy, but all the other sciences, should exert a powerful influence in promoting the cause of humanity and in bringing all peoples of the world into harmony. He referred to the United States as a vast field for scientific work in many branches, and expressed the hope that the men of the future would be able to solve the problems that arise. He struck a hard blow at certain popular methods of education, declaring that "our schools and colleges send forth every year many educated people, and it is disheartening to see how little influence they have in public life."

Columbian University, located in the heart of the city, two squares from the White House, was practically turned over to the association, and convenient meeting places for the various sections were thus provided.

The titles and presidents of the different sections are as follows:

A—Mathematics and astronomy, Professor George Bruce Halstead, Austin, Tex.

B—Physics, Professor Ernest F. Nichols, Hanover. N. H.

C—Chemistry, Professor Chas. Baskerville, Chapel Hill, N. C.

D—Mechanical science and engineering, Professor Clarence A. Waldo, La Fayette, Ind.

E—Geology and geography, Professor W. M. Davis, Cambridge, Mass.

F—Zoology, Professor C. W. Hargitt, Syracuse, N. Y.

G—Botany, Dr. F. V. Coville, Washington, D. C.

H—Anthropology, Professor George A. Dorsey, Chicago, Ill.

I—Social and economic science, H. T. Newcomb, Philadelphia, Pa.

K—Physiology and experimental medicine, Dr. W. H. Welch, Baltimore, Md.

Other societies holding meetings in conjunction with the American Association for the Advancement of Science were the American Anthropological Association, American Chemical Society, American Folk-Lore Society, American Microscopical Society, American Morphological Society, American Philosophical Association, American Physical Society, American Physiological Society, American Psychological Association, American Society of Naturalists, Association of Anatomists, Association of Economic Entomologists, Astronomical and Astrophysical Society of America, Botanical Society of America, Geological Society of America, the National Geographic Society, Society of American Bacteriologists, Society for Morphology and Physiology, Society for the Promotion of Agricultural Science, Zoologists of the Central and Western States and the Sigma Xi Honorary Scientific Society.

An examination of this array of organizations devoted to scientific specialties did not justify the hope that much attention would be given to subjects of most interest to the readers of an electrical journal, and the results were not disappointing. A few valuable papers relating more or less to electrical topics were presented, but most of them incidentally referred to devices auxiliary to other apparatus or processes, and many of these have already been described.

The association numbers among its membership more than 300 leading electrical men, many of whom belong to the American Institute of Electrical Engineers. Alexander Graham Bell, Charles F. Brush, A. E. Kennelly, W. J. Hammer, Calvin W. Rice, E. L. Nichols, Professor H. S. Carhart, Professor George F. Barker and other equally prominent authorities on electrical subjects were in attendance, but the American Association afforded no rallying point for them. "Affiliation" is the password to good standing at these annual gatherings. The American Institute and the other great national societies devoted to the numerous branches of electrical engineering are not recognized as "affiliators."

Speaking before the section of Mechanical Science and Engineering, Professor Webb, of Stevens Institute, referring to the subject of electrical engineering, said: "This is a branch of engineering which more than any other joins the scientific with the practical and bases the latter more immediately on theoretical considerations and mathematical calculations. It differs widely in this respect from other branches of engineering, and for this reason papers which otherwise might come to this section are easily included under the head of physics, just as formerly all papers of scientific affinities went together into one section. Now, since section D has been in existence, a paper, say, on Thermodynamics has been considered suitable for it, for although its matter was really a branch of physics, its engineering connections would naturally bring it to us. Now, section B is overloaded with papers, and I would suggest that some effort be made to get into this section such papers as may properly be claimed under elec-

trical engineering, interpreting it broadly if need be. This section is the engineering section, and its life depends on interesting and involving all branches of engineering in it and its success."

The cooperation of the electrical engineers may be important to the success of section D, but the value of such an arrangement to the electrical engineers is not so certain. The number of persons attending the meetings of the sections was usually between ten and fifty. In most cases the communications were made orally and no record of the discussions was made. Very few complete written papers were filed. The addresses of the various vice-presidents are the principal papers printed by the association. All the reports of the entire six days' proceedings are limited to one octavo volume of about 600 pages, and a single, unintelligible line is often the only "abstract" of a paper that was never written.

The address of Professor John J. Flather, vice-president of the Section of Mechanical Science and Engineering, entitled "Modern Tendencies in the Utilization of Power," was largely a review of the last year's progress and contained nothing particularly new. Professor Flather ascribes the present commercial supremacy of the United States to the perfection of her machinery and discusses the advances made in the application of steam, compressed air, electricity and gas. He predicts a largely increased use of gas engines and the steam turbine for operating electric generators. On the subject of electric power, he said: "The introduction of the electric motor in machine shops and factories was at first looked upon with disfavor and was opposed by many manufacturers, but the innovation obtained a foothold, and the advantages which were at first unforeseen were found to attend its use, so that now it is being very generally adopted for a wide variety of work." "There should be no comparison between the cost of power by compressed air and its brilliant rival, electricity, since each has its own field of usefulness, yet it may be interesting to note for our present purposes the efficiency of electric power. A modern shop generator belted from an engine will have an efficiency of about ninety per cent when working under favorable conditions, but as the average load is ordinarily not more than two-thirds full load, and often much less, the efficiency will not usually be more than eighty-five per cent. Since the engine friction was added to the losses in compression, so also it should be considered here, in which case the efficiency of generation will lie between seventy-five and eighty per cent. With a three-wire, 220-volt system the loss in transmission need not be more than five per cent, so that the efficiency at the motor terminals will not be far from seventy-five per cent. Where cheap fuel is available it is found in most cases that electric power can be purchased more cheaply from a central station. In those localities where the cost of fuel is high, electric power can often be purchased more cheaply from a central station, which possibly obtains its power many miles distant and transmits it electrically to a convenient distributing centre where it is used for power and light. It has been suggested that the future of long-distance transmission depends largely upon the development of oil as a fuel; but at the present time the outlook for oil fuel in general competition with coal for long-distance transmission is not encouraging."

One of the most valuable papers was on the "Construction of a Sensitive Galvanometer," by Mr. C. G. Abbot, the director of the Astrophysical Observatory, with an introduction by Secretary S. P. Langley, of the Smithsonian Institution. Mr. Langley drew attention to the marked increase of sensitiveness of the galvanometer within twenty years, and especially to the necessity of steadiness as well as sensitiveness.

The paper of Mr. Abbot was descriptive of the improvements introduced in the galvanometer for bolometric purposes at the Smithsonian Observatory. At present the instrument is of 1.6 ohms total resistance, composed of sixteen coils in series. Its needle system has forty-eight magnets in eight groups, and weighs ten milligrammes. A current of 5×10^{-11} amperes gives a deflection of one millimetre on a scale at one metre. The instrument is supported on the Julius three-wire suspension, this support, however, itself being floated on mercury. Triple magnetic shielding is made use of. The air is exhausted from the galvanometer case. Under these circumstances the instrument is so steady that one-tenth millimetre deflection can be read on a scale at five metres with time of swing of ten seconds, so that a current of 1×10^{-12} amperes is possible to measure.

Reference was made to the numerous experiments and considerable mathematical treatment which have been devoted at the observatory to the subject of construction of coils and needle systems. It was stated that in the sixteen-coil form of galvanometer sensitiveness was in some degree sacrificed for aslaticism and steadiness, and that a four-coil instrument of 1.6 ohms resistance had been used with needle system weighing 1.9 milligrammes, whose computed "constant" at ten seconds' single vibration was 1×10^{-11} but that it was less satisfactory than the sixteen-coil galvanometer.

As generally used with the bolometer, the galvanometer swing is only one to two seconds, and one millimetre deflection corresponds to about 1×10^{-9} amperes. The whole bolometric apparatus is so well behaved that the switch to the galvanometer is left in constantly for weeks without "drift" exceeding a few centimetres, and without need of rebalancing the circuit.

The section of mechanical science and engineering started a hot back-fire against the metric system of weights and measures. Professor Webb, of Stevens Institute, explained and recommended the adoption of a system having sixteen, instead of ten, as its basis, and while the members of the section did not officially commit themselves in its favor, it was evidently regarded as better than the metric system against which the opposition was determined and practically unanimous.

Mr. Allen R. Foote, formerly secretary of the National Electric Light Association, appeared before the section of social and economic science and read a lengthy paper explaining his well-known views on "the economic laws of competition and monopoly."

During the week the Smithsonian Institution, National Museum, Naval Observatory and all other scientific government bureaus were thrown open to members of the association. One of the places which attracted much attention was the liquid air plant of the Columbia Liquid Air Company, said to be the only commercial plant of its kind in this country. It occupies a building formerly used as a cable railway power-house, is equipped with 200-horse-power boilers, two compressors and a liquefier embodying some novel features of construction. The plant has a capacity for producing about twelve gallons of liquid air per hour, but the company finds little demand for it.

The social functions of the convocation were attended with quite as much interest and zeal as were given to the scientific meetings. Dinners, banquets, receptions, smokers and other entertainments were provided to the limit of the entertained. The largest brewery in the city was thoroughly analyzed by the chemists. John Hays Hammond graphically described King Solomon's mines on Friday night, and on Saturday morning the association had a final gathering at the White House, where the members were cordially greeted by President Roosevelt.

Report on the Engineering and Operating Features of the Chicago Transportation Problem.

THIS is a report by Mr. Bion J. Arnold to the Committee on Local Transportation of the Chicago City Council. Mr. Arnold was retained by the city of Chicago last July, in conformity with an ordinance passed by the city council, to report upon the engineering and operating features of the Chicago transportation problem. The report is divided into six parts, the first containing a general discussion of the street railway systems and conditions governing them. The second shows the inadequacy of present terminals and service, and makes recommendations for improvement under divisional ownership. The third section contains an exhaustive study of the population and development of the transportation business in Chicago, and a discussion of the probable future increase, with an analysis of the capitalization and financial results obtained in past operation. The fourth section considers through routes, universal transfers and the one-city-one-fare question. Part five is a discussion of a new, reorganized and unified system of street railways for Chicago; and in part six the technical problems, valuations and estimates for the different classes of service proposed are considered in detail. To the report are attached ten appendices, relating to present and recommended routes, schedules, etc., fifteen plates and a portfolio containing fourteen maps.

The following is a letter of transmittal:

To the Honorable Chairman and Members of the Committee on Local Transportation of the City Council of the City of Chicago.

GENTLEMEN:

I have the honor to present herewith my report on the several questions relating to the city's local transportation situation submitted to me by your honorable body, as set forth in the agreement between the City of Chicago and myself, bearing date of July 19, 1902, a copy of which is hereto attached.

The situation has been thoroughly canvassed. The operating statistics of the Chicago City Railway Company and the Chicago Union Traction Company have been willingly submitted, and an exhaustive study of them has been made. All facilities have been extended to me by the officials and departmental heads of these companies, and the officials of the several elevated railroad companies, as well as the several companies controlling the underground utilities, all of whom have very kindly, and with considerable trouble to themselves, furnished me with the data required in my investigation. The officials of several railway companies operating roads in other cities have courteously furnished me with valuable statistics.

All recorded information contained in the several bureaus of the city government and the personal knowledge on all subjects pertaining to the transportation matter possessed by the several bureau chiefs have been freely placed at my disposal, for all of which assistance rendered and courtesies extended I desire at this time to express my thanks and appreciation.

I have not assumed it my place to take sides in the report one way or the other on questions of municipal policy concerning which there may be differences of opinion, except where the questions are in their nature clearly engineering or transportation questions. The franchise policy of the city with reference to these matters I have conceived to be outside of my province. The plans for a comprehensive system of street railways suited to the needs of the community as set forth in the report would be the same whether the system be owned and operated by a private corporation, or owned and operated by the city, or owned by the city and operated by a private corporation under lease. So far as engineering features alone are concerned, it is immaterial whether the subway systems as outlined be owned by the city or by a private corporation.

In connection with my investigation of this problem I have considered many plans, such as movable sidewalks, elevated sidewalks, sub-sidewalk railways, and elevated structures for carrying railways, pedestrians, and the present underground utilities, some of which plans originated with me and some with others, but after a careful study of the situation the magnitude of the problem as evidenced by the great number of passengers which must be taken in and out of the business district in very short periods of time, night and morning, has forced me to abandon some of my preconceived ideas, and it is my opinion that a full realization on the part of others of the exact conditions which must govern a comprehensive solution of this problem would show the advocates of the other plans the inadvisability of their adoption. It is possible, however, that some of the suggestions relating to super-surface structures may some day prove advisable to adopt in Chicago, but probably not until the capacities of the systems recommended in this report, or other similar systems, have been reached.

The question of the utilization of the water power of the Sanitary District Canal for generating electricity and transmitting it to Chicago for the operation of its street railways has also been considered, but inasmuch as a decision regarding it need not be made at present, and from the further fact that the question was not involved in my commission, I have not submitted a discussion of it.

I have endeavored to outline not only one plan but several plans, some of which if adopted would give the citizens of Chicago the best surface railway transportation facilities capable of attainment under the conditions. These facilities can not be attained at once, and the transition will probably be gradual. In order to make it possible to get immediate relief a plan of surface tracks, which could ultimately become a part of a combined system, has been outlined. This plan provides for ample facilities on the surface for the present needs, permits of through traffic between all divisions with the joint use of tracks, and makes it possible to immediately abandon the river tunnels for street car purposes, thereby permitting the river channel to be immediately deepened for the accommodation of lake traffic, and portions of the tunnels to be still retained for future subway uses.

In closing, I desire to acknowledge the valuable assistance rendered me by Messrs. Charles V. Weston, C. E., Augustine W. Wright, C. E., Oren Root, Jr., and George C. Sikes in the preparation of this report, and to thank the respective office forces of Mr. Weston and myself for faithful and efficient services rendered.

I also wish to acknowledge the consideration shown me by the chairman and each member of your honorable committee for allowing me to perform my duty unhindered by suggestions, and I trust that the information contained in the report will be found sufficiently exhaustive and of sufficient merit to enable your committee to formulate a line of action which will lead to practical results.

Respectfully submitted,

BION J. ARNOLD,
Consulting Electrical Engineer.

Chicago, November 19.

Under the heading of "general discussion" it is shown that the cities of this country are laid out and developed on one of three distinctive plans, each plan requiring a different general system of transportation routes to serve its population. The first plan has water front on both sides, such as that of New York city. The second, or valley plan, has a river running through the centre, with the population and business districts on both sides. Pittsburg is an example of this. The third plan is known as the radiating plan, and has territory on one side of the water front. To this class Chicago belongs.

The peninsula and valley plans usually call for a comparatively small street railway track mileage, and great traffic density is found on that mileage. The radiating plan means greater street railway mileage for the population served, with much smaller gross receipts per capita. Thus, the transportation systems of New York earn about $13 per capita. Those of San Francisco earn nearly $14 per capita, while the surface and elevated lines of Chicago earn less than $10 per capita. In addition to the smaller earning capacity of the radiating plan, this offers another serious difficulty—that of preventing the dishonest use of transfers.

In discussing the present condition in Chicago it is shown how the city has been divided into three parts by the unfortunate course of the Chicago River, and the inconveniences to the population due to this condition are pointed out. Thus, the business section of the city is crowded into a small district, and there are little or no transportation facilities between the other sections of the city. The problems to be solved in relation to transportation facilities for the whole of Chicago and suburbs are: To devise some method of operation which will relieve congestion of the overcrowded thoroughfares in the business district of the city; to furnish a more ready means of intercourse between the separate divisions of the city, and to furnish a means of distributing passengers brought into the several railroad stations and for transferring them from one station to another.

The reasons for the present unsatisfactory conditions are these—the present terminal facilities, as arranged, are utterly inadequate, the operation of cars by cable power prohibits the use of the maximum capacity of the terminal facilities that are provided. The third reason is the lack of

electric power in the business district. The following recommendations are made: All cable operation should be abandoned and the cable trackage converted into either overhead trolley or underground conduit for the electrical propulsion of cars, as either of these two systems gives greater facilities and is more flexible. The territory embraced by the Chicago River on the north and west and Twelfth street on the south should be used in common by all companies for the proper location of loop tracks.

In regard to electric systems, it is held that under any circumstances overhead construction should not be permitted inside of the business district. Outside of this district the objections to the overhead trolley are mainly on account of its appearance.

Part three contains a study of the growth of population, which is exceedingly interesting. The city of Chicago is considered from its foundation. In this part of the report the free use of graphical methods made shows clearly the facts brought out in the text. The ten years from 1880 to 1890 show an increase from natural growth of 5.5 per cent compounded. The six years from 1894 to 1900 show an increase of 4.29 per cent per year compounded. The following two years show an increase of three per cent compounded.

In order to arrive at a basis to estimate the future growth of Chicago, and from this the probable future gross receipts of a complete street railway system for the city, various curves have been plotted showing the growth of several leading cities of the world. From these it is seen that the increase for the city of London has been at the average rate of 1.22 per cent per annum. The city of Paris for one hundred years shows an average increase of 1.675 per cent per annum. The city of Berlin from 1861 to 1900 shows an average annual increase of 3.23 per cent. The city of Philadelphia for one hundred years has increased at the average rate of 3.5 per cent per annum. The city of New York from 1800 to 1890 shows an average rate of increase of 3.6 per cent per annum. The growth of the territory which now constitutes Greater New York shows an increase between the years of 1800 and 1880 at the average rate of 4.06 per cent per annum. The same territory between 1877 and 1900 shows an increase of 2.8 per cent per annum. The average for one hundred years is 3.9 per cent.

By averaging all of the curves obtained by computing the growth of these cities an ideal curve is obtained which represents the average yearly increase of population for all the cities considered for different periods of time, measured in terms of population. This curve shows that the average rate of increase for all the above cities is a gradual decrease, and that with a population of 2,000,000 the average rate of increase per year is three per cent. However, the average rate of increase for Chicago for 1902 was actually 7.7 per cent, or, taken from the curve for this city, seven per cent.

Curves are then plotted showing the increase in population for a period of fifty-two years, assuming these two rates of increase and applying the law of yearly decrease on the rate of increase found from the ideal curve. Assuming the seven-per-cent rate of increase, as found from the Chicago curve, it is found that the population in 1952 would be 13,250,000. Taking the three-per-cent rate of increase as a basis upon which to apply the law, it is found that the population in 1952 would be 5,250,000.

To approximate the gross receipts of all surface and elevated lines, the receipts per capita of seventy-four cities of the United States have been compared. From the data thus obtained a curve was plotted showing the rides per capita and the rate of gross receipts in terms of various populations. For a city of 2,000,000, this is found to be 212 rides and $10.60. On this basis, and assuming a seven-per-cent rate of increase in 1902, a curve is plotted showing the yearly receipts for a period of fifty years. A similar curve is plotted assuming the three-per-cent rate of increase. These curves show that the gross receipts for 1952 should be $222,500,000 and $70,000,000, respectively, and represent the extremes between which the average gross receipts of all the combined elevated and surface lines of Chicago will vary during this period of fifty years.

From this study it is reasonably clear that the true rate of increase, and consequently the true curve upon which to base future earnings of the street railways in Chicago, is a varying one; for while it may hold at the rate of five or six per cent per annum for some years, it can not be held at this rate perpetually, but must gradually decrease, contrary to the generally accepted opinion on this subject.

For these reasons Mr. Arnold does not see his way clear to recommend any fixed percentage of increase for any length of time.

The following is Mr. Arnold's summary:

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS.

I—THE ONE-CITY-ONE-FARE IDEA.

Chicago, with respect to transportation as well as other things, should be regarded as one city, not three. Divisional lines ought to be obliterated as far as possible. A street-car passenger should be carried over the most direct route between any two points within the city limits for a single fare. Complete unification of ownership and management is the best plan for realizing the one-city-one-fare idea. The same end can be accomplished, however, but in a less satisfactory manner, under divisional ownership, by a plan of through routing of cars, joint use of tracks and interchangeable transfers. To a still less satisfactory degree the same end can be accomplished by the interchange of transfers between companies without joint use of tracks.

II—THE THROUGH-ROUTE PRINCIPLE.

Routes through the business district ought to be substituted for downtown terminals wherever possible. Outside the business district, too, the best results would follow from connecting together the detached lines now found on several streets, and operating cars over such lines from end to end on the through-route principle.

III—SUBWAYS.

A system of subways should be, and eventually must be, built to accommodate the street-car traffic of Chicago and relieve the street-surface congestion in the business districts. Galleries should be provided in connection with such subways for the accommodation of present and future underground utilities. Two subway plans are outlined in the report. One plan referred to as the subway plan No. 1, shown on map No. 11, calls for three north and south subways, from Fourteenth street on the south to Indiana street on the north, and two subways entering the business district from the West Side, utilizing the present Van Buren and Washington street tunnels and looping back to Clark street. This is a system of high-level subways throughout, with no dips. Its estimated cost is $16,000,000. The other subway plan, known as plan No. 2, shown on map No. 5, calls for practically the same north and south high-level subways in combination with three or more low-level subways from the West Side, passing under the north and south subways and reaching Michigan avenue, and should future developments warrant, under Lake Front Park as far as it may be extended. The low-level subways would require the use of elevators. The estimated cost of subways built according to this plan is $20,000,000. Plan No. 2 is recommended as best for the city from an engineering and transportation point of view, but in case this plan is deemed inadvisable for business or other reasons a system of single-decked, high-level subways, as outlined in plan No. 1, can be constructed, which will, to a large extent, accomplish the results. No subway should be built in such a manner as to preclude the operation of cars through them on the through-route principle. Under either of the plans as outlined, the whole system of subways need not necessarily be constructed at once. One or more of the subways could be built at a time and utilized separately, but with a view to their ultimately forming a part of a comprehensive system. The subway plans as submitted do not necessarily call for the removal of all tracks from the street surface in the business district, and subway plan No. 1 necessitates some surface loops. Under either plan there could be a street-surface system connecting the depots and designed to accommodate short-haul traffic in the business district. Under plan No. 2 there could also be a low-level subway system for connecting all depots, and by using it in connection with this subway all tracks could be kept off from the surface of the streets in the business district for some years to come.

IV—THE PRESENT RIVER TUNNELS.

It is inadvisable to attempt to lower the present river tunnels, and at the same

time retain them for surface railway use, for the reason that lowering the tunnels to a sufficient depth to accommodate future river traffic would involve extending the tunnel approaches at least a block further into the business district. In the interest of navigation, therefore, the tops of the tunnels ought to be promptly removed, leaving the lower parts of one or perhaps two of the tunnels for utilization later as parts of a future subway system.

V—PLAN FOR A UNIFIED COMBINED SURFACE AND SUBWAY STREET RAILWAY SYSTEM.

A plan is presented for a new, reorganized and unified combined surface and subway street railway system, comprising the lines of the City Railway Company, the Union Traction Company, the Chicago General Railway Company and the Chicago Consolidated Traction Company within the city limits, and new lines necessary to properly connect the now disconnected parts of the system. The total single-track mileage of this system as outlined would be about 745 miles, and its estimated cost, if constructed new, with everything first class throughout, but exclusive of subways, would be $70,000,000. Adding $20,000,000, the cost of the subways constructed according to plan No. 2, would make the total cost of the new system complete $90,000,000. With subway plan No. 1, instead of subway No. 2, the total cost of the new unified system would be $85,800,000.

VI—PLANS FOR IMMEDIATE IMPROVEMENT OF TERMINALS AND SERVICE.

Plans are presented for the rerouting of surface terminals in the business district, (1) under the present divisional ownership and operation, (2) under the joint use of tracks in the business district under the divisional ownership, and (3) under unified ownership and management. Immediate improvement of Chicago's local transportation facilities may be effected by substituting electric for cable power and routing cars according to any of the plans outlined, all cars from the west and north sides to enter the business district over bridges until such time as subways shall be constructed.

VII—ELECTRIC UNDERGROUND CONDUIT SYSTEM.

The operation of cars in Chicago by the electric underground conduit system is practicable and feasible. Overhead trolley construction should be prohibited within the area bounded by Twelfth street on the south and the river on the north and west. Outside of the district named the objections to the overhead trolley are æsthetic in nature, and it is for the city authorities to say—after a balancing of financial against æsthetic considerations—how much, if any, underground conduit construction should be required. The cost per mile of single track (track alone, including feeders) of electric conduit road construction would average $81,300 for a system covering the city at large, but exclusive of the cost of power, rolling stock and paving. Conduit construction, outside of the business district, should not exceed $70,000 per mile, but within the business district the cost would be about $100,000 per mile, due to the numerous curves, large amount of special work required and the extra cost of labor, due to the congestion within the district in which the work must be prosecuted. To either of the above figures should be added the cost of paving, as follows: Brick, $12,650; asphalt, $12,880; dressed granite, $18,400. Overhead trolley road construction would cost $28,000 per mile of single track, using the same weight of rail. It would cost nearly as much to convert the Chicago cable roads into electric conduit roads as to build new electric conduit roads.

VIII—GROOVED RAILS.

A grooved girder type of rail of special design is recommended for well-paved streets upon which cars operate often enough to properly clear the groove of dirt and ice. On outlying streets and on poorly paved and poorly maintained streets the girder type of rail should be maintained as best for team traffic and the railway companies.

IX—ELECTROLYSIS.

The destruction of underground utilities from electrolysis is now well in hand by the city, and if the present ordinance governing the subject is enforced no serious difficulties may be anticipated from this source, and when the underground conduit system is adopted there should be no further injury from electrolysis in the area served by the conduit system, because this system uses a complete metallic circuit.

X—THE FINANCIAL ASPECT OF THE ONE-CITY-ONE-FARE PLAN.

A unified company could afford to conduct the transportation business of Chicago on the basis of a single fare for a continuous ride anywhere within the city limits. The present divisional companies, by the interchange of transfers, could afford to do the same thing, provided they were properly protected against the fraudulent use of transfers, but it would be at a somewhat greater cost to themselves, and with greater inconvenience to passengers, than would be the case under unified management.

XI—GROWTH OF POPULATION AND TRAFFIC IN THE PAST AND ESTIMATES AS TO THE FUTURE INCREASE OF STREET-CAR TRAFFIC.

The population of Chicago has increased since its incorporation, in 1837, to 1902 at the rate of 8.6 per cent per year compounded, and is now increasing at the rate of 7.7 per cent per year. For the nine years from 1892 to 1901, inclusive, the number of revenue passengers carried by the Chicago surface and elevated lines combined has increased at the rate of five per cent per annum compounded. The increase for the surface lines during the same period has been at the rate of 1.5 per cent per year compounded. The increase for the combined surface and elevated lines from 1894 to 1901, inclusive, a period of seven years, has been at the rate of 6.3 per cent per year compounded. The increase for the surface lines alone during the same period has been at the rate of 3.9 per cent per year compounded, and the increase for the elevated lines alone has been, for the same period, at the rate of twenty-six per cent per year compounded. The population of Chicago has increased more rapidly than that of any city in the world, but it is improbable that this rate of increase should continue indefinitely. Figures and curves are presented showing the past growth of Chicago as compared with other cities, also the future results if present rates of increase should be maintained, but as this is improbable, curves are shown representing the increase in population and gross receipts that may reasonably be expected for the combined surface and elevated railways during the next fifty years.

XII—ESTIMATED COST OF REPRODUCTION AND PRESENT VALUE OF EXISTING PLANTS.

The cost to reproduce the following properties complete, with new construction and equipment throughout, would be: Chicago City Railway Company, about $17,200,000; Chicago Union Traction Company (not including the Consolidated Traction Company), about $22,200,000. The actual present value of the physical properties for electric railway purposes of the following companies, taking into consideration the obsolete equipment and construction, which must be discarded, but not taking into account any franchise rights or earning capacity of the properties, is estimated as follows: Chicago City Railway Company, about $12,000,000; Chicago Union Traction Company (not including Consolidated Traction Company), about $15,000,000.

XIII—NEED FOR REGULATION OF TEAM TRAFFIC.

At the present time team traffic interferes with street cars to an unwarrantable extent. A reasonable regulation of team traffic is essential to the improvement of street-car service.

XIV—THE UNION ELEVATED LOOP PROBLEM.

The junction points are the ultimate limiting capacity of the Union Elevated Loop. At the present time, however, the platform stations are the limiting factor. The first and simplest way to increase the capacity of the loop is to lengthen the station platforms so that two trains can load and unload at a station at the same time. When the capacity of the junction points is reached, added facilities can be provided by building stub-end terminals just outside the loop. The terminal capacity of the loop could be increased by dividing the present loop into four smaller loops, but presumably there would be public objection to such a plan, because it would involve encumbering more downtown streets with elevated structures, and it is, therefore, not recommended. The ideal solution of the elevated loop problem would be to utilize the loop structure as sections of through routes between the different sections of the city.

THE REQUIREMENTS OF MACHINE TOOL OPERATION WITH SPECIAL REFERENCE TO THE MOTOR DRIVE—II.

BY CHARLES DAY.

I can call to mind half a dozen of the largest plants in this country, establishments noted the world over for their product, whose shops are most inefficient as far as equipment and organization are concerned, but through exceptionally clever design or selling ability the inefficiency of the shop is outweighed many times. This is no excuse for these conditions, and such concerns may, under changing conditions, be seriously affected by the inefficiency to which we refer. It is proof, however, that very few noted establishments have more than a few lines developed to the high pitch demanded by present conditions, the final result being that one will average with another, but from widely different causes.

We will now devote our attention to shop conditions, and, if necessary, it would be easy to analyze still further the fixed charges, labor and material shown above.

The former can be divided into insurance, depreciation, repairs, power, etc. Labor may be subdivided into productive and non-productive, and material into proportion of steel, cast iron, brass, etc. The more subtle factors, such as sanitary conditions and light, must also be constantly borne in mind.

Of all these factors we will consider only the equipment and means which may be necessary to enable the workman to use it to its full capacity.

We must start in the pattern shop or forge department, and see that everything is done to facilitate future handling and machining.

A lug on a heavy casting to make it easy to catch hold with the crane, or in some cases additional metal to remove, to prevent the possibility of working too close to the chilled scale, will frequently effect more saving than is possible by other means.

I wish to be understood that my remarks from now on will relate to shops doing a general class of work, as it is much easier to arrive at a high standard where parts are duplicated in large numbers. In the latter case we can profit by experience, while in the former we must anticipate each move. In one instance machines are designed for a given duty, while in the second they must be adapted to a certain class of work, and as a result seldom handle any job to the best advantage.

We must ever keep in mind that the object of our work should be to execute a job most efficiently the first time in the shop; efficiency being used in the broadest sense and not necessarily implying that the cheapest production is arrived at as attained when manufacturing in quantity, as special tools such as are frequently required in such a case would not be justified.

Referring again to the example under consideration, we will suppose the castings have been received in the shop and the method of machining determined upon. A certain amount of metal has to be removed and a definite finish is required, our object being to accomplish this result in the least possible time, or, rather, at the least expense.

Instead of taking any given example, I will now endeavor to outline the course of reasoning which must be applied before we can intelligently answer this question.

The tool steel is the keynote to the situation, and a complete knowledge of its characteristics and possibilities form the starting-point for all further work. Carbon steel will give a finer finish on steel than the air-hardening variety, and for form cutters is still largely used. Where heavy roughing cuts are possible, air-hardening-steel has unquestionably replaced it; and, in fact, the recent developments in the processes of hardening have been the direct means of revolutionizing old methods of machine tool design and so-called shop practice.

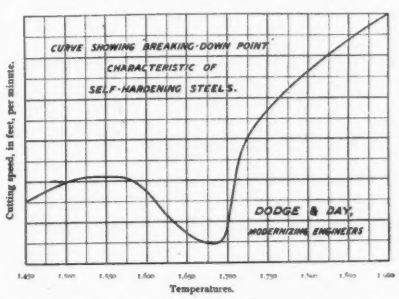

CURVE SHOWING BREAKING-DOWN POINT CHARACTERISTIC OF SELF-HARDENING STEELS.
Cutting speed, in feet, per minute.
DODGE & DAY, MODERNIZING ENGINEERS
Temperatures.

FIG. 2.—CURVE SHOWING PRINCIPLE OF TAYLOR-WHITE PROCESS OF TREATING TOOL STEEL.

We must ever bear in mind that "best shop practice" should mean "arriving at the desired result at the least cost," and can be used in a relative sense only. We constantly hear machinists condemn a means of arriving at a result irrespective of its merits, their reason being that "it is not good practice." If drilling with a feed of one-sixteenth of an inch per revolution gives the desired finish in much less time, it is certainly good practice, and if under these conditions we find a sharp point on the drill is not essential, so much the better.

I have cited this particular instance, as it recently came under our notice when experimenting with some twist drills, which continued to do good work when pronounced as ruined by several machinists who were watching the tests.

The influence of the Taylor-White process has been so revolutionary in character that I feel justified in dwelling upon it for a few moments. The underlying principle of this discovery is clearly shown on the accompanying curve (Fig. 2), which is plotted from values of cutting speeds and temperatures. It will be seen that this curve rises from the zero point until 1,550 degrees are reached, when the cutting values suddenly fall off, this representing the full extent of our knowledge when the experiments at Bethlehem were undertaken. The most interesting and valuable fact, that these values again increase if the hardening temperature is carried beyond the "breaking-down point," was the result of work just referred to, and the superiority of steel treated in this way as compared with Sheffield mushet—which was probably equal to any air-hardening steel on the market at that time, may be expressed as follows.

	Mushet.	Taylor-White.
10 C. steel	1	2.2
80 C. steel	1	3.5
Cast iron	1	1.3

These figures are the result of a series of tests conducted by the Franklin Institute and represent the facts as nearly as they could be determined. There are now a number of makes of steel in the market treated along the lines explained above, which give equally as good results.

An exact knowledge of the cutting speeds of which these two tools will permit when machining different materials, and the power to pull various cuts under all conditions, are absolutely essential if we wish to properly design machine tools or use them to their full capabilities in actual service. The value of this information is now being realized by several of the machine tool builders, and the results are already being felt in the shop in the form of much more efficient machine tools.

The motor drive makes the measurement of power so simple that we may arrive at these results with comparatively little difficulty. We have recently conducted in the shops of our clients, the Link-Belt Engineering Company, a series of experiments to determine the best air-hardening tool steel for use on cast iron, Fig 3, showing the testing lathe and necessary accessories. This particular lathe, which I will describe later, gives 126 spindle speeds, increasing in five per cent

increments, and is especially adapted to this work. The electrical instruments on the left give a record of the energy absorbed, and the cutting speeds were carefully determined by suitable instruments.

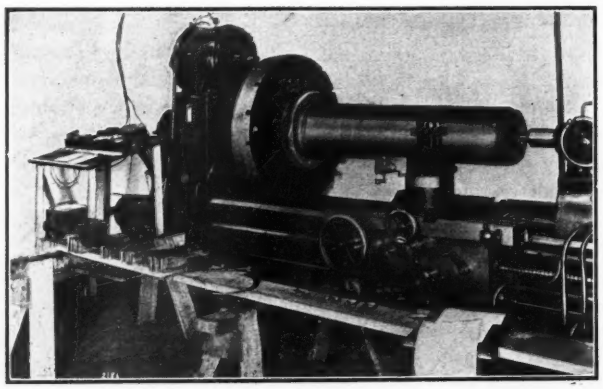


FIG. 3.—MOTOR-DRIVEN LATHE, EQUIPPED FOR EXPERIMENTAL WORK.

Fig. 4 is a portion of a record and shows our method of tabulating this data. One hundred and twenty-five tests on various tools were made in this series of experiments, the depth of cut and feed being kept constant and the speed varied so that the tool would last just twenty minutes.

A few experiments will prove of little value, as the factors are so variable in character. The uniformity of the tool must be determined, then the cutting speed for material of all kinds, and finally the relations between these quantities should be ascertained and empirical formulæ derived. This has been done for certain conditions by Mr. Carl Barth, but I will refer to this work later.

With the present light on the subject, it seems strange, indeed, how machine tools could have been designed in the past, and it is not strange that we can now criticise the course pursued. We do feel, however, that the manufacturers of such apparatus are slow in adopting the proper course, although in every instance we have found them open to conviction and glad to discuss the problem from the present standpoint.

It is not now my intention to discuss the subject of machine tool design, but I do wish to say that the most inefficient part of most shops is the machine equipment, and until the user of this apparatus realizes this point and demands machines designed along the correct lines, the desired result will not be reached.

To those who have not given the subject close study, this statement may seem to be without foundation; but it matters not what type of tool we consider, its shortcomings can be readily pointed out. The feeds on the average drill-press are ridiculously low, the power supplied and rigidity of the frame on machines using multiple cutters are out of all proportion to the work we should be able to absorb at the cut, and so on.

Reference was made above to several tool builders who are breaking away from preconceived ideas of machine design; the roughing lathes made by Lodge & Shipley, and the Bullard Machine Tool Company and the Bickford Radial coming to my mind in this connection. The Lodge & Shipley reducing lathe, shown in Fig. 5, was designed to pull, if I remember correctly, cuts aggregating in cross-section three inches deep and one-sixteenth-inch feed, the cutting speed being fifty feet per minute, and material fifty carbons steel. The belt will deliver fifty horse-power at the tool post, and the construction of the bed is such that this power can be utilized without undue vibration.

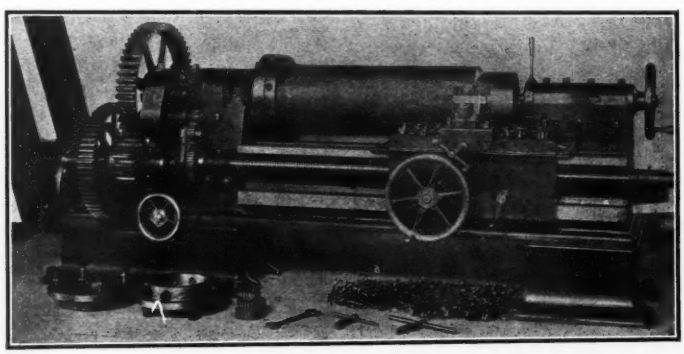


FIG. 5.—LODGE & SHIPLEY REDUCING LATHE.

In all discussions of this kind we must ever keep before us the fact that some work will permit of heavy cuts and coarse feeds and some will not, but even in the latter cases there are many ways open to cheapen production. Where the work is light and the operations of but short duration, it is very essential that the changes in speed should be obtained with the least loss of time; in other words, "ease of handling" is a most important factor.

I think we are now in a position to consider the method of driving machine tools, the requirements to be met being the following: A machine having been designed for a given duty, its maximum and minimum speeds are limited by the character of the work it will do; the number of speeds is determined by the character of the metal machined, and the uniformity of the tool steel and the power required is fixed by the most severe conditions it must meet.

Experiments on Cutting Speeds

DODGE & DAY

November, 24th, 1902. Kind of Steel in Tool SELF HARDENING.
Forging No. Cast Iron. Kind of Tool Right Hand Roughing.
Cutting (Dry / Wet) TOOL— 1" by 1" Clearance Angle of Tool 8 Degrees.
Rake Angle of Tool (Front 2 Degrees. Side 20 Degrees.

Experiment Number	Feed	Depth of Cut	Cutting speed in Feet per minute	Heat in Tool	Duration of Cut in minutes	Diam. at Edge of Cut in inches	Diam. at Bottom of Cut in inches	Feet moved from Top end of Lathe	Volts	Amperes	Feet traveled per Foot Tool in Cutting	REMARKS
24	.0606	3/16	97 91.7	Taylor White No.2 H.S.H. No.1	16 1/4	21 3/8	21	0	150 154	30 5	16 1/8	RUINED.
25	.0606	3/16	103 100	Capitol No.1	20	"	"	16 1/2	170 172	24 5	21 1/2	FAIR.
26	"	"	105.6 104	Capitol No.2	20	"	"	37 7/8	171 172	24 5	22 11/16	GOOD.
27	"	"	104 101	Capitol No.3	18	21"	20 5/8	0	167 170	27 5	14 1/2	RUINED.
28	"	"	104 101	Taylor White No.1 T.W.	11 1/2	"	"	14 3/8	164 172	26 5	12 1/2	RUINED.
29	"	"	100 99.1	Jessop No.1	20	"	"	27	132 138	26 5	20 7/8	GOOD.
30	"	"	105 101	Jessop No.2	20	20 5/8	20 1/4	0	166 167	24 5	22 11/16	RUINED.
31	"	"	107 107.6	Jessop No.1	20	"	"	22 1/2	166 170	24 5	23	GOOD.
32	"	"	115.2 111.7	Jessop No.4	15	"	"	48 1/2	168 170	25 5	16 1/2	GOOD.
33	"	"	125 115	Jessop No.3	2 1/12	20 1/4	19 7/8	0	168 170	28 5	2 3/4	RUINED.
34	"	"	118 109	Jessop No.2	10 3/4	"	"	2 3/4	167 170	29 5	2 13/16	RUINED.
35	"	"										

FIG. 4.—PORTION OF RECORD SHOWING METHOD OF TABULATING TESTS ON TOOL STEEL.

For the average machine tool we do not think present conditions demand a closer speed regulation than ten per cent, as no good means have yet been reached for determining the character of the metal, and in the average shop little is understood about the relations existing between feed, speed and depth of cut for various materials.

There are two sides to the question, *viz.*, the refinement of speed required by the various elements with which we are dealing and the possibility of using this refinement to its full efficiency in actual practice. The first set of requirements may demand a speed regulation of ten

per cent, while the second would indicate that it is extremely difficult to use it to advantage in actual practice with present facilities.

We have recently visited nearly every shop in this country where an extensive motor equipment has been installed and without exception have found these conditions to exist.

For certain classes of work, slide rules based upon the empirical formulæ referred to above seem to us to be the only solution to the problem. By means of these most ingenious rules, it becomes possible to instruct the workmen how to do the work to ensure maximum efficiency, the feeds, speeds and cuts all being dictated indirectly by the positions of the various handles and gears controlling these factors.

These slide rules must be in the hands of a force of men who are perfectly conversant with machine-shop work and able to lay out the course any particular piece should pursue in going through the shop. The value of these rules—if surrounded by the proper organization—has been fully exemplified by Mr. Taylor at the Bethlehem Steel Works, and I imagine most of you are thoroughly acquainted with the story of the development of this plant while under his direction.

The cutting speed for steel is determined by the tensile strength and elongation, while for cast iron the problem is still more complex. The hardness is not only affected by the chemical composition, but the method of cooling and size of casting, so that we seldom find two castings that will permit of machining at the same speed.

It is possible, however, by careful observation and experiment, to ascertain approximately for a given shop the cutting speeds of which various jobs will permit, so it is absolutely essential to have some good means of determining it. It is impossible to judge the speed by eye, even where a man works on the same tool continuously; nor will the character of the chip when cutting cast iron indicate the proper speed.

As a means of remedying this difficulty, we have used charts (see Fig. 6), which enabled the men to ascertain the cutting speed from a knowledge of the diameter of the work and location of belt and gears.

We have found great difficulty in making the men sufficiently familiar with these charts to use them to advantage, and now feel that the explanation necessary largely offsets their value. The antagonism when introducing new methods or machines, so often evidenced by the men, is largely eliminated when the innovation is so extremely simple that its use can be grasped by the men at once.

A much better scheme than the charts is the use of tables designating the spindle speed for each point of the controller or position of the belt, as feeds are frequently enumerated on lathes, etc.

When slide rules are not used, a "speed tally" on each machine would be the only

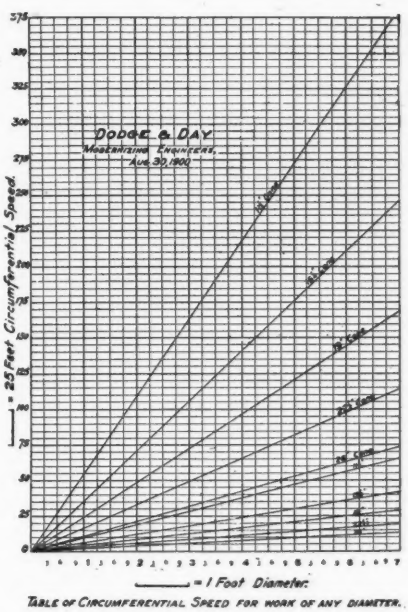

DODGE & DAY
Modernizing Engineers
Aug. 30, 1900
= 25 Feet Circumferential Speed.
= 1 Foot Diameter.
Table of Circumferential Speed for work of any diameter.

FIG. 6.—CHART USED FOR DETERMINING CUTTING SPEEDS.

proper way of enabling the workman to know the speed at all times. No skill is required in its use or time lost in making the reading. A tachometer suitable for this work has not yet been placed upon the market, but on a recent visit to Milwaukee I had the pleasure of seeing one that has been developed and patented by Mr. A. P. Warner, of the Northern Electrical Manufacturing Company, of Madison, Wis., and which I think will meet all requirements.

We have not touched on the labor problem, and in this connection I will say that we must ever bear in mind that the effort is proportional to the incentive, and in most shops running with an old equipment the latter has been utterly inadequate to call forth continued energetic service from the men.

In our estimation the most characteristic and valuable features of the electrical systems, which we will now consider, are the elimination of complication and physical effort in handling the machines, and the direct advantage resulting from this cause may be very far-reaching.

The inefficiency of the belt and step cones, as a means of machine-tool driving, even when installed in such a way as to permit of good crane service, is too well understood to demand much consideration here. It is not a question of does it fulfill present conditions, but will it meet the new requirements resulting from the advance in tool steel, and our better knowledge on the subject? It certainly will not.

The motor is an equally poor investment if, after its introduction, the shop is run along the same old lines, and for this reason an understanding of its possibilities is most essential. I refer, of course, to the motor on individual tools, and, although my remarks are general in character, it is understood that we do not for a moment advise its use on every machine, our views on this subject being rather conservative. The accompanying chart, Fig. 7, was made by us some months ago to show at a glance the different methods on the market for motor-driving machines, and may prove of interest here. The constant-speed motor, particularly of the alternating type, is so simple in character we naturally turn to it as a possible solution to the problem. It lacks, however, the two great essentials, ease of handling and speed regulation, and all attempts to supply these shortcomings by mechanical means have so far proved unsatisfactory.

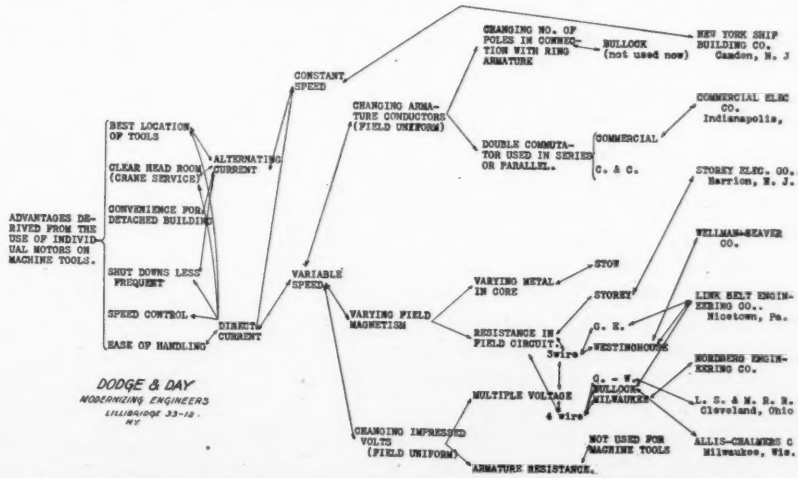


FIG. 7.—PRINCIPAL ADVANTAGE OF VARIOUS METHODS THAT MAY BE ADOPTED FOR DRIVING MACHINE TOOLS.

(To be continued.)

*EXPERIMENTS WITH THE PUPIN SYSTEM OF LONG-DISTANCE TELEPHONY.**

BY F. DOLEZALEK AND A. EBELING.

The Siemens & Halske Company, in cooperation with the Imperial Postal and Telegraph Bureau, has conducted investigations in regard to the improvement of long-distance telephony by introducing self-induction according to the Pupin system. The results have been so favorable that the Siemens & Halske Company has decided to secure the European patent rights.

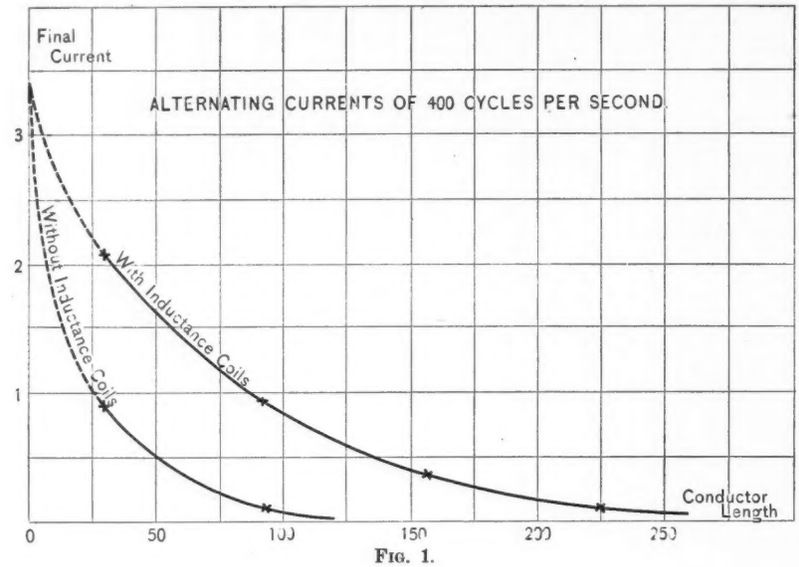


FIG. 1.

The principal difficulty encountered in long-distance telephony and telegraphy by means of alternating currents, or quick electrical impulses, is known to be the deleterious effect of electrostatic capacity of long overhead lines, and particularly cables. The transmision of an electric wave over a conducting wire consists in a continuous change of electrokinetic into electrostatic energy. The greater the capacity of the line, the greater is the intensity of this conversion and, as a consequence, the greater is the loss of energy through heating. In order to check this loss it is necessary to increase the cross-section of the wire for an increased length of line or capacity.

There is, however, a second way of compensating for the evil effect of capacity—that is, by increasing the self-induction. The increased impedance diminishes the intensity of the charging current and, as a consequence, the heat loss. Formerly this increase was sought by covering the conductor with iron or other paramagnetic material.

Researches show that the increase in the self-induction obtained in this way is not sufficient to compensate for the capacity of the cable. A hundred-fold increase in self-induction can easily be obtained by Heaviside's, Thomson's, or Pupin's method, by which coils of wire are introduced at many points. In Pupin's method the objectionable reflection of the wave is avoided and only the desired effect of self-induction is obtained.

The following experiments show in a striking manner the great technical value of Pupin's theory and indicate that a new field for long-distance telephony is opened. These first experiments prove that with equal conductors four times the distance heretofore possible can be covered, and a further increase is to be expected. Cities as widely separated as Paris and St. Petersburg, Berlin and London, can have telephone communication, and short lines can be considerably improved by the Pupin system.

After a consideration of the theory the authors pass to the practical tests. For this work a cable lying between Berlin and Potsdam, 32.5 kilometres (twenty-two miles) in length, was placed at the disposal of the Siemens & Halske Company by the Imperial Postal Bureau. This cable consisted of twenty-eight pairs of conductors of copper wire one millimetre in diameter. These wires were covered by the usual paper insulation. The cable, outside of Berlin, is laid in the ground and is sheathed with lead and asphalt. Within Berlin an armored cable is run through the conduit system. Fourteen pairs were available for these tests, so that a direct comparison of loaded and unloaded lines could be made. To avoid injury to this cable inductance coils could be placed at junction boxes only. Every second junction box was used, making the distance between the coils about 1,300 metres (4,290 feet).

Each coil had a resistance of 4.1 ohms and an inductance of about 0.062 henry. The resistance of the cable conductors per kilometre with the coils was about 23.5 ohms. The capacity was 0.37 microfarad per kilometre, giving, according to the Pupin equation, a damping factor of 0.0106.

The inductance of the simple cable circuit was measured by means of an alternating current of 900 cycles, and found to be 0.0003 henry per kilometre. The damping factor of this simple cable was 0.06 at 900 cycles. The introduction of the coils increased the self-induction 200 times and decreased the damping factor to one-sixth. This diminution gave a marked improve-

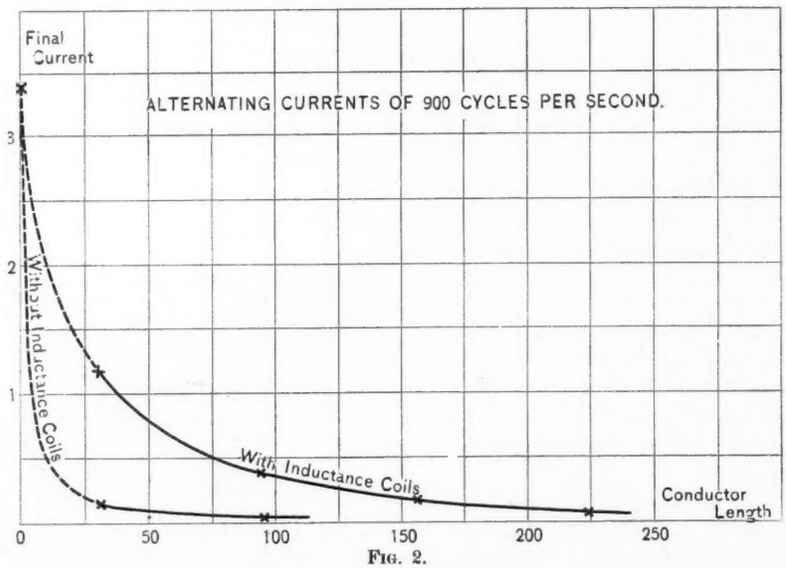


FIG. 2.

*Abstracted and translated from the *Electrotechnische Zeitschrift.*

ment in the transmission of speech. Comparing a cable 32.5 kilometres (twenty-two miles) in length, equipped with Pupin coils, with a similar line without the coils, it was found that in the latter case it was necessary to stand within half a metre of the receiving apparatus in order to understand; but with the loaded line the voice could be clearly heard ten metres away from the receiver. The receiver used in these tests was the Siemens microphone instrument of the type used by the Imperial Postal Department. To increase the length of the line three pairs of conductors were connected together, giving a total length of 97.5 kilometres (sixty miles). Comparing loaded and unloaded lines of this length, the difference between the two was even more marked. Five lines were then connected together, giving a circuit 162.5 kilometres (110 miles) long. Over this wire only a trained ear could detect sounds when no coils were used; but when the coils were connected in, a very clear transmission was possible. This line, loaded with coils, gave a transmission of speech as loud as a single line 32.5 kilometres (twenty-two miles) long having no coils. Connecting thirteen of these circuits together, with the coils, conversation could be carried on, but was very faint, the length of line being 422.5 kilometres (280 miles).

Comparing a conductor, between Berlin and Potsdam, of bronze wire two millimetres in diameter with a similar length

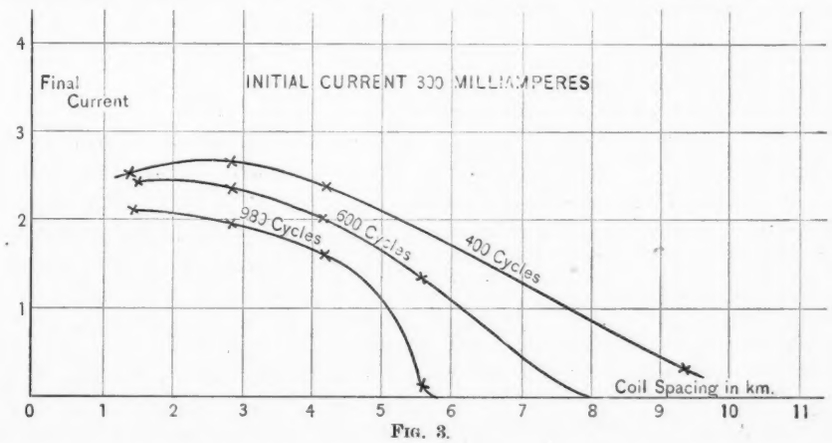

Final Current
INITIAL CURRENT 300 MILLIAMPERES
980 Cycles
600 Cycles
400 Cycles
Coil Spacing in km.
0 1 2 3 4 5 6 7 8 9 10 11
1 2 3 4

FIG. 3.

of cable equipped with coils, the transmission was approximately the same. This result varied somewhat with the weather. In good weather the overhead conductor was somewhat louder than the cable, but in bad weather the reverse was true. These results show that a cable constructed upon the Pupin system, having a conductor one millimetre in diameter, is practically as good as an overhead line two millimetres in diameter. The coils were placed in an iron case which was joined to the junction box, and the whole filled with insulating material.

After these cable tests, the Imperial Post Office Bureau placed at the service of the Siemens & Halske Company an overhead line of bronze wire two millimetres in diameter, which was divided into six sections, reaching from Berlin to Magdeburg, being 150 kilometres (100 miles) in length. A second line between Berlin and Magdaburg was also used, this having a length of about 180 kilometres (120 miles) and consisting of a bronze wire three millimetres in diameter. Before equipping the two-millimetre line with coils, transmission over this was not as good as over the three-millimetre line. Pupin coils were then introduced in the two-millimetre line every four kilometres. These had a resistance of about six ohms and an inductance of 0.08 henry. This gave a much louder transmission of speech than over the three-millimetre line.

In mounting the coils the usual pole insulator was replaced by a bracket supporting two insulators, one of which supported the coil. This preserved the good insulation of the line.

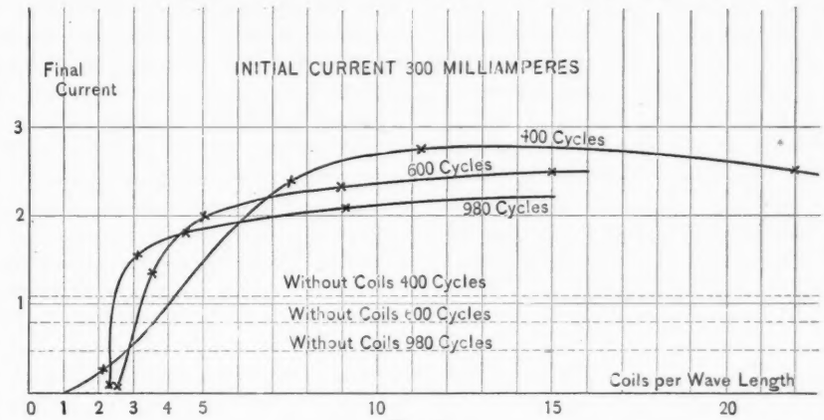


FIG. 4.

As these tests gave qualitative results only, a series of experiments was then conducted to obtain quantitative results of the reduction of the damping factor following the introduction of inductance. Alternating current of small intensity and high frequency, corresponding to that used in telephone work, was employed. The frequency varied from 900 to 400 cycles, and the intensity of the current was a few milliamperes, being measured by means of a reflecting dynamometer. The unavoidable impedance of the receiving apparatus made a strictly theoretical condition impossible, so that it was decided to seek practical conditions, and to this end the inductance and resistance of the measuring instruments were made to correspond to those of a microphone receiver, being about 0.4 henry and 400 ohms, respectively. Fig. 1 shows the results of a series of measurements at a frequency of 900. The current sent into the line was 3.38 milliamperes for all cases. In this diagram the ordinates represent the current received at the end of the line in milliamperes, and abscissæ the length of the line in kilometres. Lengths greater than 32.5 kilometres were obtained by connecting in series one or more pairs of conductors, these pairs having no marked inductive effect on each other. These curves show clearly the reduction predicted by theory. With a simple length of cable between Berlin and Potsdam the current received from a Pupin cable was 1.2 milliamperes. For an unloaded cable it was 0.17 milliampere, the latter being only one-seventh of the former. With a length of 97.5 kilometres the transmission of speech over a Pupin cable is forty-eight times better than over a simple cable, a similar damping taking place in the former case with a length of line five times as great as for the unloaded cable. Fig. 2 shows some meas-

urements made with a frequency of 400 cycles. The difference between the loaded and unloaded cables is still more noticeable, although the damping in the unloaded cable decreases considerably for smaller frequencies. A comparison of Figs. 1 and 2 shows that the ratio of the damping for frequencies of 900 and 400 cycles is, for the Pupin cable, as is 1 to 1.6, and for the simple cable as 1 is to 6. The loaded cable transmitted all frequencies almost equally well, which explains the clearness of the speech transmitted through such a cable.

Similar measurements were made for the overhead conductors between Berlin and Magdeburg. The initial current was, as before, 3.38 milliamperes. The following intensities were received at the far end at a frequency of 900 cycles. The line 150 kilometres long and two millimetres in cross-section, without coils, gave 0.53 milliampere. The same line, with coils, gave 2.2 milliamperes. The line 180 kilometres in length and three millimetres in diameter, without coils, gave 0.84 milliampere. During these measurements the insulation of the line was about twenty-five megohms per kilometre. The figures show that the introduction of coils on the two-millimetre line increased the current at the receiving end four times, and that this exceeded the value for the three-millimetre line.

The effect of the insulation of the line upon the transmission currents was tested and the measurements show that the influence of insulation on the two-millimetre loaded line is greater than on the three-millimetre line, and that with the very low insulation of one megohm per kilometre the Pupin line is still better than the three-millimetre line.

These measurements show that the Pupin system would enable the weight of copper for equal transmission to be reduced to one-fourth, or, with the same weight of copper, a distance four times as great can be spanned.

Measurements were then made to determine the effect of the positions of the coils. The principle of the Pupin system is the recognition that a diminution of damping can only be obtained when the inductances are introduced at distances equal to fractions of a wave-length. With a greater separation of the coils, reflection of the waves occurs and damping increases quickly. Tests were made upon an ordinary paper-covered cable of copper wire eight millimetres in diameter and twenty-eight kilometres long, with alternating currents of frequencies of 980, 600 and 400 cycles. For all these measurements the self-induction per kilometre was 0.075 henry, and the corresponding capacity was 0.04 microfarad. The wave-length was, at 980 cycles, 12.9 kilometres; for 600 cycles, 21 kilometres, and for 400 cycles, 31.2 kilometres.

Twenty coils, each having an inductance of 0.11 henry, were used in the outgoing and return lines, distributed between twenty, ten, five and two points, respectively. This gave a constant total inductance with a variation in spacing of from 1.4 to 10 kilometres. In Fig. 3 are shown the currents received at the end of the 28-kilometre line for the various frequencies. The values are plotted as functions of the coil spacing. The resistance of the receiving apparatus was 370 ohms; its inductance 0.15 henry.

For a given coil arrangement the delivered current decreases rapidly with the increase in the frequency. With a coil spacing of six kilometres, an alternating current with a frequency of 980 cycles is entirely reflected. With the best long-distance receiver no sound is perceived. Alternating currents of from 600 to 400 cycles, with a coil spacing of six to ten kilometres, were entirely choked. A successive filtering of the various frequencies was noticed with an increasing distance between the coils. Fig. 4 shows the delivered current plotted as a function of the number of coils per wave-length.

The final current falls rapidly to zero with a coil spacing between two and six per wave-length, showing a very sharp, critical limit. To determine the value of the final current when the receiving apparatus possessed no induction, experiments were carried out with receiving apparatuses of various impedances at a frequency of 900 cycles. Plotting these values graphically and exterpolating, it was found that with no impedance in the receiving apparatus the final current would be between 1.2 and 1.7 milliamperes. The calculated value is 1.45 milliamperes, showing fair agreement.

These tests show that by introducing inductance coils in long-distance telephone lines, according to the Pupin system, great and practical effects are secured, as indicated by theory, and that long-distance telephony enters upon a new stage of development. Moreover, the problem of transatlantic telephony is shown to be possible, although the cost of such a marine cable might be too high, and very great technical difficulties of construction and laying a sea cable with coils in deep water are to be expected. For the lesser depths of the Mediterranean, the North Sea and the Baltic Sea the Pupin cable can be constructed and laid, so that direct telephone connection between Berlin and London, Berlin and Copenhagen, etc., can be established without difficulty.

A Portable Capillary Electrometer.

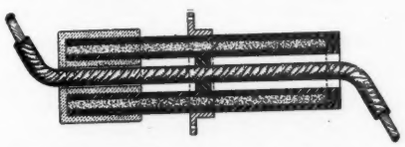
At a meeting of the British Physical Society, held December 12, Mr. S. W. J. Smith exhibited and described a portable capillary electrometer. This instrument is a modification of that form of electrometer which consists of two wide tubes joined by a cylindrical capillary tube. The two wide tubes are sealed at the top to prevent evaporation, and are also joined near the top by another tube which allows free motion of the liquids within the apparatus. Distribution of the mercury can be altered by means of a third cross-piece provided with a tap. To prevent the platinum wires forming the electrodes being wetted by the acid, should the apparatus be laid on its side, the lower ends of the tubes may be slightly constricted above the ends of the platinum terminals, or these terminals may consist of amalgamated platinum foil when the constriction is unnecessary. The usual form of spring key has some disadvantages, so this is replaced by a pneumatic key consisting of a U-tube closed at one end and communicating at the other end with a pneumatic pressure ball, and containing mercury in the bend. Platinum wires are fused into the tube, so that by squeezing the ball the same change of contacts is produced as by pressing the lever of the ordinary spring key. With such an arrangement the sensitiveness of the instrument is doubled; and using a microscope, magnifying fifty diameters, a potential difference of 0.0001 of a volt can be detected without difficulty.

Electric Fire Pump in Operation at Rouen, France.

A consular report describes an electric fire pump now in use in Rouen, France, which was invented by M. R. Lefebvre. It is composed of a centrifugal pump driven by an eight-horse-power motor, which runs normally at 2,000 revolutions per minute. The motor is operated from a railway or power circuit, taking about 500 volts. Connecting cables coiled on reels are provided, giving the pump a range of about 650 feet. The pump carries 650 feet of hose, and throws water over 100 feet, thus giving an operative distance from the power supply of 1,400 feet. The whole machine can be placed on a hand-cart or on a two-wheeled wagon drawn by one horse. The total weight, with accessories and two men, is about 2,300 pounds. The motor and pump are about forty inches long, twenty inches wide and twenty inches high.

Electrical Patents.

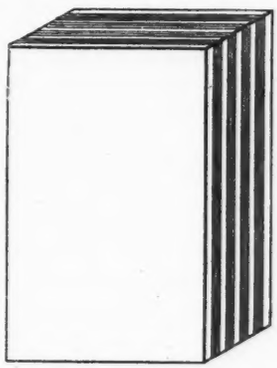
Insulators, as commonly constructed, are made of a single piece of rigid insulating substance—such, for example, as glass or rubber—with a comparatively short distance between the wire and its support. A new insulator, designed especially for use with conductors of high-potential current, has been patented by Mr. George H. Rupley, of Schenectady, N. Y., the patent being controlled by the General Electric Company. The improved insulator is a compound structure in which a rigid insulating substance is used as the framework, the body portion



INSULATOR FOR HIGH-POTENTIAL CONDUCTOR.

being formed of a filled-in material which is of relatively much higher insulating power. Moreover, the insulator is constructed in such a shape that the superficial distance between the conductor and the support is very much increased. A tubular body is formed of double walls spaced apart, the space between them being filled with some suitable solid or liquid substance of high insulating power. The walls are preferably in the form of two concentric tubes formed of some hard insulating material, such as wood, hard rubber, fibre, porcelain or the like. The annular space between them is closed at one end by a washer of similar material, and this space is then filled with some softer insulating substance, such as oil, asphalt, resin, mica compound, or the like. The open end of the annular chamber is then closed either by an insulating washer or an annular cap of porcelain having double flanges fitting inside and outside the body of the insulator. If a liquid or semi-liquid hydrocarbon or other filling substance is used, which expands and contracts with changes of temperature, a relief vent may be employed, such as a spout projecting from the upper side of the body and opening to the atmosphere, thus permitting the filling substance to rise and fall in the spout without danger of bursting the tube. The line conductor passes through the inner tube, which is of considerable greater diameter than the same, so as to afford a body of air between the conductor and the tube and thus add to the dielectric value of the insulator.

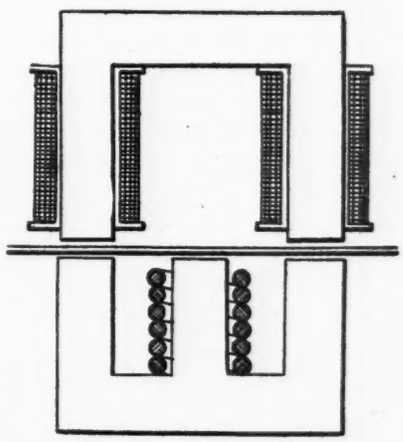
An electric brush has been devised by Mr. Robert D. Laughlin, of Ravenna, Ohio, and patented by the National Carbon Company, of Cleveland, Ohio. The invention relates in improvements in brushes for electric generators, motors, controllers and electrical appliances of all sorts where contact between relatively movable surfaces is required—as, for example, between a fixed brush and a rotating commutator. The object is to provide an article of this nature that will lubricate the surface of the commutator and thereby reduce the wear thereof incident to the contact, but which will be an exceedingly good conductor of the electric current. The brush is a laminated structure composed of alternate layers of plumbago and carbon, any number of these layers being employed and extending from one end to the other of the brush, the two outer layers, however, being of carbon. The brush is described as an exceedingly good conductor of current—rather better than a brush made of carbon alone. The graphite, of course,



ELECTRIC BRUSH.

lubricates the commutator surface, against which the brush is held in contact, and, moreover, because of the laminated structure Foucault or eddy currents will not be developed therein. In constructing this brush, the several layers are separately made, preferably by being forced out of a so-called "Jumbo" press, in the form of ribbons, and are then cut into plates of the required length. These plates are laid together while still green and pressed into intimate contact, after which they are baked or cured by heat in suitable ovens.

An improvement in induction alternate-current meters has been patented in this country by Otto T. Blathy, a resident of Budapest, Austria-Hungary. This invention relates to an alternate-current meter operating on the Ferraris principle and giving indications in good proportions through the whole range of the readings combined with very small power consumption on the coils. In order to obtain these valuable qualities care must be taken that the braking action of the driving fields may be as small as possible as compared with the strength of the permanent braking magnet, the said braking action of the driving fields being a variable quantity depending upon the variations in their strength. In other words, the fundamental condition of a good proportioning of the meter is that the driving moment of the active fields should be as great as possible as compared with their braking moment. The peculiar arrangement of the active magnetic fields adopted in apparatus according to the present invention secures a great driving moment combined with a small braking moment of the fields. A good proportioning of the readings on the whole scale requires, further, that for the lower curved part of the magnetizing curve corresponding to small magnetizing currents, a straight line should be substituted. The inventor has found that by suitably combining the iron cores of the main current magnetic field with air-gaps greater than that required for the free movement of the rotating disc a good proportioning of the readings can be secured even with small currents in the main circuit, thus at the same time increasing the driving moment of the fields and reducing the losses of power in the coils. The meter consists of two iron cores—the one, U-shaped, and the other E-shaped, the one placed above and the other below the rotating disc in such an manner that the poles of the U-shaped core face the outer limbs of the E-shaped core. The U-shaped core



ALTERNATING-CURRENT METER.

receives the voltage coils, while the main current coils are wound around the middle of the E-shaped core. This construction has the following advantages—first, the voltage field circuit is well closed magnetically, requiring in consequence only small magnetizing currents; second, the main current field contains a great air space ensuring thus proportionality in magnetization even with small currents; third, the eddy currents induced in the rotating disc by the magnetic field extend well into the fields of force acting dynamically upon them so that an energetic driving moment is ensured.

HIGH TEMPERATURE ELECTROCHEMISTRY—NOTES ON EXPERIMENTAL AND TECHNICAL ELECTRIC FURNACES—IV. (Concluded.)

BY R. S. HUTTON AND J. E. PETAVEL.

Ruthenberg[1] has worked more particularly on the magnetic concentration of low grade ores and their subsequent fritting in the electric furnace.

Conley[2] proposes the reduction of iron ores by passing them between two high resistance plates which are kept heated by the passage of a current; the metal falls into a hearth, which is also electrically heated.

Gin has brought forward a method of heating mixtures of iron oxide and sulphide ores, with production of sulphuric acid and ferrosilicon as by-products.

Keller[3] has designed a furnace which is being employed in the works at Kerrousse (Morbihan).

Processes of electric melting by induced currents have been produced by Benedicks,[4] in Sweden, and Schneider,[5] in France; in both cases the metal contained in an annular crucible forms the electric conductor surrounding an iron ring in which rapid variations in magnetic flux are produced. Benedicks's contrivance is similar in principle to a welding transformer, the entire secondary circuit of which is formed by the molten metal. This process is in actual work at Gysinge, where 300 horse-power is employed, and 1,500 tons steel can be produced per annum. Schneider, on the other hand, produces an alternating magnetic field by the rotation of a shuttle-wound armature. The outlook of these inventions can only be regarded as immediately hopeful in localities in which water power is available at an exceptionally low cost; the value of any economically successful process, however, can hardly be overestimated.

Glass—The accuracy with which temperatures produced by electric methods can be adjusted has led to several proposals for the application of the electric furnace to the glass industry, where, as is known, the temperature regulation is one of the most important factors. Trials are being made on a commercial scale at Plettenberg (Westphalia).[6] With regard to the fusion of quartz, since the temperature required is very high, the electric is the only method available for fusing this material in bulk. Considerable difficulties will have to be overcome, however, before this most valuable substance can be manufactured on a commercial scale.

Conclusion—Although the above account is by no means exhaustive, we feel that we have already reached, if not exceeded, the limits of space which are usually allotted for a paper of this kind. In our brief review of the subject it has in most cases only been possible to describe summarily for each product one particular method of manufacture, which, however, we have tried to choose as being one worked on a large commercial scale, but it must be borne in mind that by so doing it has not been our intention to in any way detract from the value of other methods, which, although less generally used, may frequently possess advantages over those we have mentioned.

Perhaps, however, before closing we may be allowed to say a few words with regard to the theoretical efficiency of electric furnaces, about which so much has of late been written. Calculations have been made referring to each of the manufactures, but the reliability of these varies largely from case to case. When dealing with the highest temperatures very few data are available with regard to the specific heat, latent heat, or heat of combination of the various materials employed. It was previously customary to assume a constant specific heat, but more recently this has been shown to be untenable, and most of the modern calculations consider the specific heat as a linear function of the temperature, relying for their values for the higher temperatures on a very considerable extrapolation. The actual specific heats have been experimentally determined for a limited number of substances up to some 1,500 degrees centigrade, and it is hardly necessary to insist on how considerable an error can be caused by boldly applying these values to twice the absolute temperature. In addition it must be remembered that the second factor in the calculation, the actual temperature of a furnace, is in most cases practically unknown.

The temperature of volatilization of carbon is usually taken as 3,400 degrees centigrade, but this is no measure of the temperature of the arc flame which may be considerably higher. On the other hand, the average temperature of the furnace is always considerably below that of the volatilization point of carbon.

The consequence of this rash way of dealing with the subject is that the estimates of the theoretical amount of heat required differ by nearly 100 per cent, as has been shown by Kershaw in the case of calcium carbide.[1]

With regard to those of the resistance furnaces in which the temperature is comparatively low, more accurate data can be obtained, and finally, in the electrolysis of fused salts, the calculations give a much more trustworthy result, depending as they do largely upon the electrochemical equivalents, which are known with some accuracy.

The determination of the total loss of heat by radiation from an electric furnace provides, however, valuable information on one of the important factors in the efficiency, but the final criterion in all commercial work must necessarily be the number of tons yield per horse-power-year. In describing the various methods it has been of great advantage to have means by which personal experience of the process could be obtained by direct experiment, and for this we are indebted to the foresight of Professor Arthur Schuster, F. R. S., who, several years ago, realizing the increasing importance of the subject when considering the plans of the building in which we are now assembled, made ample provision for an electrochemical laboratory.

[1] Ruthenberg, *Eng. Patent* 12 867, 1902; *Electrochemist and Metallurgist*, vol. 2 p. 12, 1902; *Jahrb. der Elektrochemie*, vol. 1 p. 516, 1902.

[2] Conley, *Electrochemist and Metallurgist*, vol. 2 p. 16. 1902.

[3] Bertholus, *Notice sur la Fabrication des aciers au Four Electrique*, Paris. 1902.

[4] Benedicks, *Eng. Patent* No. 18,921 of 1900.

[5] Schneider, *Eng. Patent* No. 7,388 of 1901.

[6] *Zeitschr. für Elektrochemie*, vol. 8, pp. 419–421, 1902; Völker, *Eng. Patent* 23,903, 1900.

[1] Kershaw, *Electrician*, vol. 46, pp. 164, 245, 267, 1900.

Northwestern Electrical Association.

The eleventh annual convention of the Northwestern Electrical Association will be held at the Hotel Pfister, Milwaukee, Wis., commencing on Wednesday morning, January 21, 1903.

Reports and papers on subjects of special interest to central station men will be read and discussed.

An attractive entertainment programme is being arranged, and a pleasant and profitable time is assured to all who attend this convention. The association extends, through the secretary, Mr. Thomas R. Mercein, Milwaukee, Wis., a cordial invitation to all who are interested in electrical matters.

Independent Telephone Association of Wisconsin.

The Independent Telephone Association of Wisconsin, will hold its next annual convention in Milwaukee, Wis., on February 11 and 12. The Wisconsin association is one of the strongest of the state organizations, and this meeting will be one of great interest and value. Telephone manufacturers and supply houses will make exhibits at this convention. The Pfister Hotel will be the headquarters of the association.

Reviews of Current Engineering and Scientific Literature.

Giving Concisely the Substance of Important Papers in the Scientific, Electrical and Engineering Press of the World.

The Differentially Compounded Motor.

For the majority of purposes speed regulation of the simple shunt motor is sufficient, but there are some instances where closer regulation than can be secured by the use of the simple shunt motor, without excessive cost, is desirable. For such purposes a differentially wound motor can be used. In this article, Mr. W. R. Kelsey discusses the design and use of compound motors for this purpose. An equation is deduced, involving the current through the armature, the total flux, and the speed. As the currents through the armature and the flux are the only variables in the operation of motors if the speed be constant, curves for different loads may be advantageously plotted, from which it is easy to determine the flux required for any given output of motor or current flow. The construction is graphically shown and clearly explained. The author then considers the question of securing the proper variation in flux, which is found by the previous construction. Since the series coils act in opposition to those of the shunt, the energy expended in them is wasted so far as conversion into mechanical work is concerned, and they should therefore be as few as possible. On this account it is not advisable to work iron at high inductions. The magnets of the machine must therefore be of larger section and heavier than in other types, and the weight of copper is also increased. The efficiency is somewhat reduced by the increase of turns in the field, both series turns and shunt, and the greater length of each per turn. There is, on the other hand, a lessening of the loss due to the smaller inductions used. The conclusions are that a differential motor may have a good speed regulation, but is heavy and expensive in cost and working. Its speed should be high and its resistance low, that a moderate difference in flux may be sufficient. Its shunt should be connected across the terminals, and, finally, since the magnetization curve is not a straight line, it may be advantageous to shunt part of the main current from the field through a resistance having a high temperature coefficient.—*Electrical Engineer* (London), December 12.

The Electrical Central Station at the Dusseldorf Exhibition.

This article gives a detailed description of the generating plant at the Düsseldorf Exhibition, and compares this with the station at the Paris Exhibition in 1900. At the former station there were twenty-nine primary power engines and thirty-one generators, giving a total output of 9,000 kilowatts. These generators were supplied by five firms. The average capacity of the continuous-current generators was 152 kilowatts. For the polyphase machines this was 765 kilowatts. All the parts of these generating sets are given in a table. This shows that a generating set consisted of an engine of the vertical, triple-expansion type, which was rated at from 2,500 to 3,000 horse-power. This drove a 2,000-kilowatt generator, three-phase, giving 5,000 volts at ninety-four revolutions per minute. A second unit consisted of a 2,000-horse-power engine driving a 2,000-kilowatt, three-phase generator. The largest continuous-current set was a 500-horse-power engine driving a 440-kilowatt generator giving 600 volts. This station furnished energy to five systems. The first was a single-phase system at 10,000 volts, which was used exclusively for lighting the grounds. The second and third systems were three-phase at 5,000 or 2,000 volts. The fourth and fifth systems were continuous current at twice 220 or twice 115 volts. There were 40,000 incandescent lamps, 1,200 arc lamps and 600 motors aggregating 5,200 horse-power. The respective firms which installed the generators had their separate switchboards. These were connected to underground cables to the main distributing switchboard, from which the distributing cables led to the transformer stations of the grounds. One exception to this arrangement was the 10,000-volt plant for lighting the grounds. This was kept entirely separate from the other systems. A diagram of the wiring scheme and particulars of the distributing system are given. Arc lamps are used on single, polyphase and continuous-current circuits. These varied in type from fifteen-ampere lamps, burning fifteen hours, to three-ampere lamps, burning 200 hours. Fourteen Bremer arc lamps were exhibited. Two of these lamps were rather exceptional, as in these four arcs were arranged in series on a 220-volt circuit, taking thirty amperes. A number of other arc lamps are described in some detail. One noticeable feature about the lighting scheme was the emergency lighting system. This consisted of 300 incandescent lamps distributed all over the grounds. Current could be obtained from three independent sources—either from the large storage battery plant, from two gas, motor-driven dynamos, or from two machines driven by steam turbines. The connections for these lamps were made at the main switchboard in all cases. All conductors for lighting were carried overhead.—*Engineering* (London), December 12.

The Photometry of Electric Lamps.

At a recent meeting of the British Institution of Electrical Engineers Dr. J. A. Fleming read a paper on "The Photometry of Electric Lamps." The paper was quite long and deals very fully with all phases of the problem. The first part of this is devoted to the question of standards. The author thought that often greater accuracy in measurements was assumed than was warranted. A case was mentioned where incandescent lamps being imported from New York showed a difference of twenty per cent in candle-power when compared with lamps of a similar rating made in London, the American lamps being brighter. The difference in the rating was thought to be due to a variation in the standards, as the lamps were not measured by careless observers. After fully considering all of the various types of standards now advocated, the author comes to the following conclusions: A platinum standard in some perfected form may prove to be the best ultimate standard of luminous intensity. Apart from the not insuperable difficulty of its employment, it realizes in a very perfect form the conditions necessary for such a standard; namely, a perfectly pure material maintained at an absolutely constant temperature in a definite condition. The violle platinum standard has the additional recommendation that it is not only a unit of light, but the unit of brightness. Much work has been done in producing standard incandescent lamps. The form adopted contained a rather thick carbon filament in the form of a simple loop, and contained in a large bulb. A number of these lamps were made at the Edison & Swan factory in 1896 and carefully photometered against a pentane air-gas standard. A certain number of these lamps were set aside and used but occasionally. In the month of March, 1902, these lamps were rechecked to ascertain how far any difference might have arisen in the six years between the pentane air-gas standard and these carbon filament lamps. The results of the measurements showed that in six years, during which these lamp standards were much used, this set had probably remained as constant in light-giving power at the same voltage as the pentane standard. The author did not think that measurements upon the intrinsic brilliancy of the crater of the arc lamp held out a promise that this source of light would fill the requirements of a standard.—*Electrical Times* (London), December 18 and 25.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Demonstration of the Cooper-Hewitt Lamp.

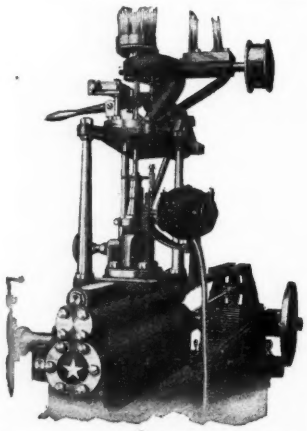
A cable despatch from London describes the first European demonstration of the Cooper-Hewitt mercury vapor lamp. This was given by Mr. George Westinghouse, Thursday evening, January 8, at the offices of the British Westinghouse Electric and Manufacturing Company, Limited, London, before a large number of distinguished men. The demonstration was most successful. A notable incident of the occasion was the exhibition of the new Cooper-Hewitt static converter. This device consists of a small globe less than one foot in diameter, into which are inserted electrodes, the number depending upon the character of the current to be converted. For a three-phase system there are three positive electrodes and one negative. The three positive electrodes are connected to the three phases of the system. The negative electrode is connected to one side of the working circuit, the other side of which is connected to the neutral wire of the three-phase system. By sending a discharge through the converter in a manner similar to that used in starting the Cooper-Hewitt lamp, the negative electrode resistance is broken down, and current will pass through the converter from some one of the three positive electrodes. As the electromotive force sending this current dies down, that at one of the other two electrodes is increasing and will maintain the current flow in the same direction, and this process continues. Current can not pass through the converter in the opposite direction because of the negative electrode resistance, the device acting as an electrical check valve. The device can be adapted to any alternating-current system. It is simple, cheap and efficient, and has no moving parts. Much interest was shown in the exhibition of these remarkable inventions.

After the demonstration, Mr. George Westinghouse gave a dinner at Claridge's Hotel, at which nearly 100 guests were present, including many who were at the exhibition of the Cooper-Hewitt apparatus. Among them were Lord Kelvin, Lord Rothschild, Lord Morley, Lord Claude Hamilton, chairman Great Eastern Railway; Lord Allerton, chairman Great Northern Railway; Sir Henry Oakley, chairman Central London Railway; Colonel Mellor, chairman Metropolitan Railway; Emil Garcke, chairman British Electric Traction Company; Colonel Yorke, of Board of Trade; Sir Henry Tyler, Sir Charles Rivers Wilson, John Walter and A. F. Walter, proprietors of the London *Times;* Moberley Bell, manager of the London *Times;* Robert Benson, Colonel Hunsiker, Edward Speyer, James C. Stewart, Sir Joseph Lawrence and many other well-known men.

An Electric Speed Controller.

This machine has been designed particularly with a view to governing any or all of the machinery in a water-power plant from some central point. The apparatus is extremely simple, consisting merely of two small push-buttons on each panel on the switchboard or pilot switchboard, which connect through three wires to a small electric motor similar to that used for driving fans. This motor, through suitable mechanism, acts upon the valve stem of the governor in such a manner as to lengthen or shorten the connection between the centrifugal balls and the valve itself.

In the accompanying illustration the part of the device attached to the governor is very clearly shown. The motor is mounted upon a bracket which is clamped to the regulating valve of the governor. Upon the armature shaft is



ELECTRIC SPEED CONTROLLER.

mounted a small worm driving a worm gear on a vertical pinion shaft. This pinion transmits rotary motion to a gear which, being threaded through its hub, acts as a right and left coupling to draw together or push apart the two portions of the valve stem upon which it rotates. The pinion which drives the gear is long enough so as not to interfere with the up and down travel of the gear, and therefore the control of the valve by the centrifugal ball is not affected in any manner.

In bringing alternating-current generators into synchronism, the switchboard attendant can manipulate the two push-buttons without taking his eyes for an instant away from the synchronizing lamps or corresponding device. If it is desired, the man at the switchboard can, without leaving his post, shut down any generator, bringing it to a complete stop and afterward starting it again.

These governors can also be furnished with an automatic electric attachment, which is not intended to allow variations in speed, but merely to completely stop and start the water-wheels from a distant point. In some instances it is desirable to use both attachments—that is, the speed changing and the stopping and starting. The attachment of these devices to governors now in service may be easily made by any good mechanic, it being only necessary in ordering to state the type letter of the governor, and, in electric plants, where the push-buttons are to be located on the switchboard, the thickness of the marble, etc.

These devices are made by the Lombard Governor Company, 36 Whittier street, Boston, Mass.

The Pennsylvania Railroad's New York Terminal.

The magnitude of the work to be done in creating the New York city terminal for the Pennsylvania Railroad has aroused great interest. The peculiar situation of New York city, due to its location on an island, and its separation from another island, upon which is practically another section of the same city, has made the construction of a suitable terminal exceedingly difficult. The plans now proposed contemplate the construction of a double tunnel to project from New Jersey to Manhattan, with a four-tunnel extension to Long Island and a double terminal plan involving both Manhattan and Long Island. In addition to this great undertaking, part of the Long Island Railroad is to be operated electrically.

It is impossible at this time to give detailed description of the tunnel and terminal. The plans, however, include the transformation of certain portions of the western division of the Long Island Railroad to electrical traction and the erection of two power-houses, aggregating about 100,000 horse-power, one on Long Island and the other in New Jersey.

At present interest centres chiefly upon the project as a whole, and, among engineers particularly, upon the methods

adopted by the Pennsylvania Railroad for carrying out this work. The management of this railroad has had a large experience in undertakings of magnitude. At this time extensions and improvements are being made to its entire system, the cost of which it is understood will exceed that of this terminal. Having this condition in mind, and appreciating the many new problems which are going to be presented in the construction of the tunnel, the management has divided the work into four main parts—the tunnels, the architecture, the mechanical and electrical engineering and the bringing of the railroad into and through the terminals.

It has created a commission of engineers to design and supervise the construction of tunnels. Architects have been appointed to plan buildings, and a commission of engineers to lay out the mechanical and electrical equipment. The engineering department of the Pennsylvania Railroad will bring the road into the property thus created. With this arrangement, the entire work can be handled expeditiously and conveniently. The commission selected to design and produce the tunnels consists of Colonel Charles W. Raymond, United States Army, engineer for New York Harbor, chairman; Charles M. Jacobs, civil engineer, chief engineer of the North River section; Alfred Noble, chief engineer, chief engineer for East River section; William H. Brown, chief engineer of the Pennsylvania Railroad, in charge of the tracks and terminal yards; Gustav Lindenthal, chief engineer, bridge commissioner of New York city; George Gibbs, mechanical engineer, first vice-president Westinghouse, Church, Kerr & Company.

The architectural work has been delegated to Messrs. McKim, Mead and White, who have had wide experience in work of a similar character.

Westinghouse, Church, Kerr & Company have been appointed mechanical and electrical engineers and constructors of the engineering part of the undertaking, and the architects have made the same company their engineers, thus ensuring harmonious working between the architects and engineering commissioners. Westinghouse, Church, Kerr & Company have also been appointed engineers by the Long Island Railroad Company for the electrification of its Atlantic avenue line.

The tunnel commission holds regular meetings, considering the departmental work of its individual members. These meetings are attended by Mr. Mead, the representative of the architects, while the engineers are represented by Mr. George Gibbs, the first vice-president of the company.

A special Pennsylvania Railroad terminal committee has been formed within the Westinghouse, Church, Kerr & Company, which meets at regular intervals, and includes in its membership representatives of the various branches of engineering involved. These proceedings constitute a continuous and systematic record of engineering development, design, decision and progressive work based on the operations of the special departments whose heads are members of this special committee. Thus far the active engineering work has consisted mainly of investigations and determinations concerning the methods, quantities and the feasibility of numerous plans. The commission, the architects and the engineers work independently upon their segregated duties and together in adjusting the various proposed features and methods to the possibilities and limitations of the others. From this work, a final set of plans will come before the management of the Pennsylvania Railroad for final approval, and upon approval, the work of construction will then proceed.

As the tunnel commission has been at work since early last spring, much preliminary work had been carried out before the passage of the franchise. The engineers have already practically completed plans for the Long Island powerhouse so that work can be begun upon this immediately. The two power-houses will jointly serve the entire traction system and will have provisions for relaying each other and for serving the New York terminal singly or jointly.

Although public interest will centre largely upon the terminal structure in New York, the engineering and general railroad features will, from the standpoint of cost and complexity, be the more important.

For the terminal proper, an area 1,800 by 500 feet will have to be excavated to a depth of some forty to fifty feet, and within this space will be erected what corresponds to a train shed in other terminals.

The course pursued by the Pennsylvania Railroad in this undertaking is a departure from usual practice, but the wisdom of this method can not be questioned as thereby are secured the services of some of the highest authorities on engineering work.

The Annual Report of the Lighthouse Board.

The annual report of the Lighthouse Board of the United States for the year ending June 30, 1902, has been received. This contains maps and detailed information about all the districts of the country. The first section of the report is a record of all changes and additions to the service.

German Briquette Machinery.

A consular report calls attention to the highly developed briquetting machinery now in general use in Germany, and suggests that there might be a good field for this machinery in certain parts of this country where there are large accumulations of low-grade coal. There are in England, in western New York, New England, Michigan, Illinois and other western states vast beds of peat. There are in the Dakotas and the Gulf states large quantities of lignite and peat, and there are in almost all the coal-mining states quantities of bituminous dust and anthracite culm, all of which, by the employment of modern machinery, might be added to the fuel supply of our country.

German briquette factories are divided, in respect to the crude material, into two general groups—those which make household briquettes from lignite or carbonized peat, and those which produce the industrial briquettes using as basic material coal dust or slack. The first of these are made from brown coal and peat, and to a small extent from anthracite dust, and are used for grates, heating stoves, cooking stoves and ranges, constituting the principal household fuel of Berlin and other German cities. The machinery for the manufacture of these briquettes is made by several large establishments, among which may be cited the Zeiter Eisengiesserei, at Zeitz, in Saxony; the Maschinen Fabrik Buckau, at Magdeburg, and the Königen Marienhütte, at Cainsdorf, in Saxony.

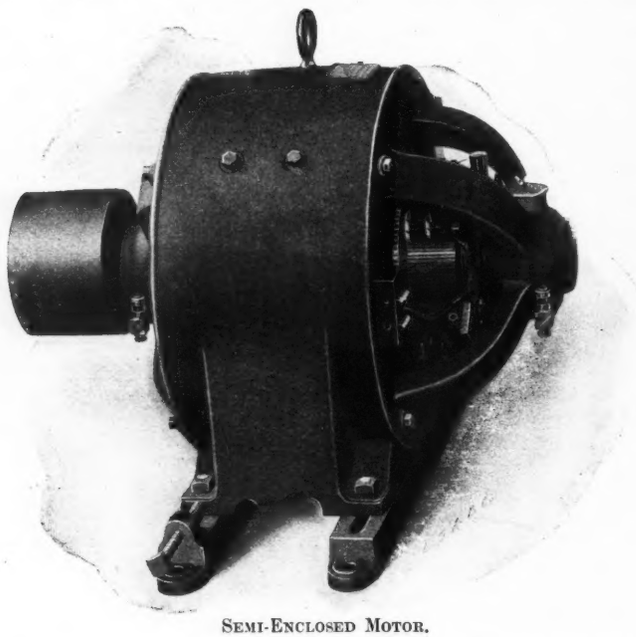
Industrial briquettes are used in Germany for firing locomotives and other steam boilers, for smelting and reverberatory furnaces. They are made of bituminous coal dust held together by a matrix of mineral pitch, the percentage of the latter depending greatly upon the fatness of the coal dust.

Briquettes are made in various forms, from egg-shaped ovals to brick forms suitable for piling up in confined spaces. They range in weight from three to ten pounds. When burned whole they consume slowly and give out a steady, moderate heat. For a hotter fire they are broken up, and in this condition are used in boilers and annealing furnaces, etc.

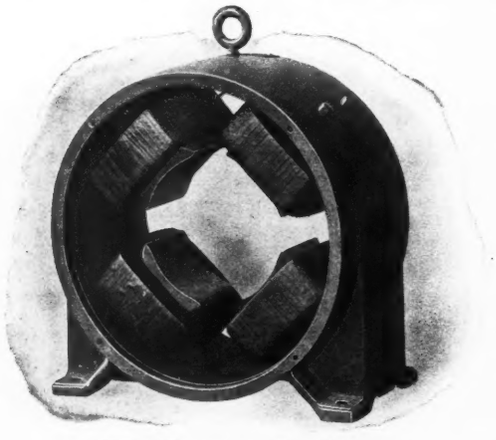
American mine owners and operators may ascertain the theoretic value of their materials for briquette making by sending samples directly, or through the American consul at Berlin—Mr. Frank H. Mason—to the Export Syndicate of Briquette Machinery Manufacturers, at No. 59 Fredrich Strasse, Berlin. These samples should contain ten pounds of the material in the exact condition in which it will be available for practical use. Should the material be moist, it must be sealed up so as to prevent drying out in passage.

Direct-Current Stationary Motors and Generators.

The machines illustrated in the accompanying engravings have been designed for continuous belted work under normal atmospheric conditions. They are built for slow-speed work ranging in size from three and one-half to twenty-five horse-power, and two and three-quarter to eighteen and three-quarter kilowatts capacity, and for medium speed work in sizes from five to thirty horse-power and three and three-quarter to twenty-two and one-half kilowatts capacity. The general construction of these machines is such that the armature is more or less enclosed. They are all of four-pole construction, and may be supported on the floor, ceiling or wall by turning the magnet frame around in the pedestals until the feet of the frame come in the desired position.



SEMI-ENCLOSED MOTOR.

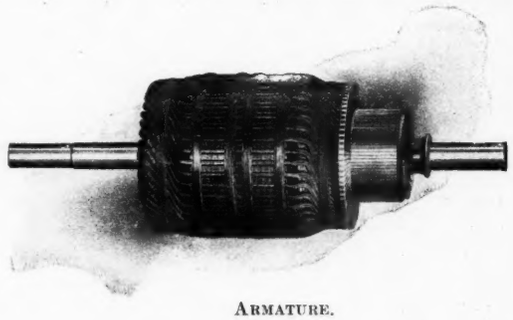


FIELD FRAME AND FIELD COIL.

The armature cores are composed of specially selected sheet iron laminations, which are assembled directly on the shaft. Each lamination is carefully annealed and insulated before being assembled. Ventilating spaces are provided at suitable intervals to afford ventilation for the core and windings. The cylindrical or barrel type of winding is used, the coils being machine wound on suitable forms. This form of cylindrical winding affords large radiating surface for the conductors, reducing their length to a minimum, and thereby reducing the loss in the armature due to resistance. The armature and coils are insulated separately with selected material, and possess the ability to withstand extremely high temperatures. The coils, after being insulated, baked and inspected, are imbedded in the slots on the surface of the armature core, and are held securely in position by band wires. After being wound and banded the armature is again baked and the commutator and bearings are then finished, a special effort being made to carefully balance the whole armature.

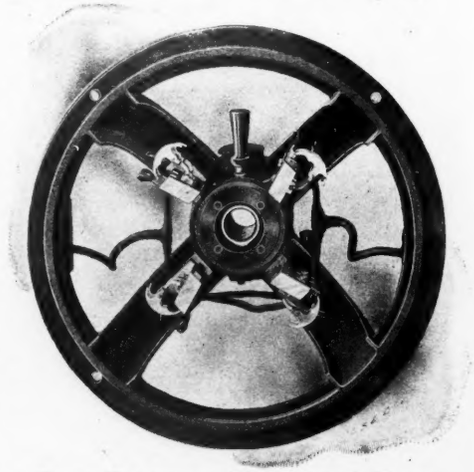
The magnet frames or yokes are made of special soft iron of high permeability. The feet of the machines are cast on the magnet frames. Each frame has four spots or pads to which the pole-pieces are bolted. The pole-pieces are of special laminated construction, being made of the same grade of material as that which is used in the armature. Each pole is held in place on the magnet frame or yoke by means of two bolts, the field coils being securely held in place on the poles by means of the pole-tips.

The bearings are supported by the pedestal heads, which are bolted to each side of the magnet frame or yoke. The bearings are self-aligning, and are made of a special grade of phospor-bronze. Each bearing is lubricated by means of two oil rings which carry oil from the oil chamber to the shaft. The bearings, oil rings and oil chambers are so designed that there is ample bearing surface and a liberal oil supply.



ARMATURE.

Each machine is equipped with four brush-holders mounted on an adjustable yoke. The brush-holders are made of cast brass and arranged for carbon brushes. Each holder contains two or more carbons, each of which is independent of the others, each carbon having a flexible copper connection to the brush-holders. The carbons slide in the brush boxes, which are carefully finished on the inside, each carbon being held in contact with the commutator by means of a finger actuated by an adjustable spring, giving the carbon an even pressure on the commutator. The commutator bars are made of drop-forged copper, and are designed with a liberal depth. These are insulated from the commutator shell with mica, which also composes the insulation between the bars. This mica is of a grade specially selected for its hardness, ensuring an even wearing with the copper bars.



BRUSH-HOLDER AND BRUSH-HOLDER FRAME.

The machines are made to jigs and gauges, making the parts interchangeable.

These machines are manufactured by the Elwell-Parker Electric Company of America, with headquarters at Cleveland, Ohio.

Mixing the Cables Up.

In a brief account of the laying of the first section of the Commercial Pacific Cable Company's cable which appeared in last week's issue of the ELECTRICAL REVIEW, there was given what was intended to be a description of the land cable. In this, however, the land cable, the shore end of the marine cable and the deep-sea cable were somewhat mixed.

As is well known, the land cable was manufactured by the Okonite Company, of New York. It consists of a four-conductor cable insulated with okonite and sheathed with lead. It is about eight miles in length. This is one of the finest telegraph cables that was ever made, and the Okonite Company is to be congratulated on the skill and success of the undertaking.

The deep-sea cable is a single conductor, insulated with gutta-percha and heavily armored; the shore end of the cable has two conductors and extends six miles from the shore, one conductor being grounded on the sheathing. This cable was made in England.

New York Electrical Society.

The two hundred and thirtieth meeting of the New York Electrical Society was held at the lecture room of the American Institute, New York city, on Wednesday evening, January 7. The subject for consideration was "Electricity and Fire Insurance."

Dr. Samuel Sheldon, president of the society, made some appropriate introductory remarks. He was followed by Mr. Joseph Sachs, who spoke on "Electric Fuses in Relation to Insurance Hazard." The speaker called attention to the merits and shortcomings of the ordinary open safety fuse. He described various types of enclosed fuse. A device of this kind that will act satisfactorily on short-circuit is not difficult to make, but short-circuit rupture is not the only element to be considered. The filling of the tube enclosing the fuse must be of such a character that when a short break in the fuse occurs, due to a slight overload, the circuit will be interrupted. The question of correct rating was touched upon. The present method of rating gives the current which will flow continuously through the fuse without injury, while the Underwriters' National Electric Association desires to have fuses rated at eighty per cent of the maximum carrying capacity. The speaker called attention to the improper practice of using low-voltage fuses in series on a high-voltage circuit, and low-capacity fuses in parallel to increase the capacity of the circuit. It is difficult to make two fuses equal in conductivity, and hence it is almost impossible to make them act simultaneously when connected either in multiple or in series.

The president then introduced Mr. Arthur Williams, who spoke on the subject of "The National Electrical Code and High-Tension Circuits." The speaker traced the developments of the national electrical code. The first code was issued in 1893. Much confusion was caused by the requirements then made. Since that time the code has been modified and improved until to-day it is the accepted standard. The latest subject to be taken up by the underwriters is that of high-tension transmission circuits. The voltage of high-tension circuits has been raised rapidly during the last few years, and their use has extended. As these circuits pass through villages and towns, and as there have been heretofore no rules governing their installation, it has been thought desirable to have some control over the manner of construction. Hence the recent action of the insurance and electrical authorities interested in the national code. The rules under consideration relate chiefly to the method of line construction, and the distance the wires must be carried from the buildings and from the conductors of other light, power and signaling systems.

The next speaker was Mr. J. C. Forsythe, who spoke on the "Relation of Electricity to Insurance Rates." The electrical hazard resolves itself into three general heads: The use of proper material, the proper maintenance of supervision of equipment, and the life or the length of time the plant will be operated before the natural deterioration will be such as to render its continuance in service a source of danger.

A communication was read from Dr. A. E. Kennelly, describing the work which had been done by the transmission committee of the American Institute of Electrical Engineers in conjunction with the Underwriters' National Electrical Association.

The discussion was participated in by Messrs. Patterson, Osterberg, Petty, Eidlitz and Lorain.

American Institute of Electrical Engineers.

The one hundred and seventy-second meeting of the American Institute of Electrical Engineers will be held on Friday evening, January 23, at 12 West Thirty-first street, New York city. The topic for discussion will be "Telephone Exchanges." Mr. Thomas D. Lockwood, electrical engineer and advisory electrician of the American Telephone and Telegraph Company, will present a paper upon "The Evolution of the Telephone Switchboard." The discussion will be opened by Mr. J. J. Carty, chief engineer of the New York Telephone Company. Other prominent telephone engineers are expected to participate.

The New York Automobile Show.

One of the most conspicuous features of the Automobile Show, which opens on the evening of January 17 at Madison Square Garden, will be the improvements in design and construction of automobiles. Not since the great bicycle boom has there been such interest shown in an industrial exhibition, or such a demand for room in the big amphitheatre. All of the ordinary exhibition space has been taken up, the basement having been fitted up to accommodate the exhibitors of foreign and American made power-driven machines. Europe will be well represented. While foreign manufacturers have been very active in working out improvements in the construction and finish of their machines, American manufacturers have made great strides during the past two years, and the product of this country compares favorably with anything in the world. The American makers feel confident that before another year goes by they will lead every other country in automobile designing and building.

Although considerable attention has been given to the development of speed in automobiles, the Madison Square Garden exhibit will show that the makers have not neglected the matter of general appearance and comfort. The cars in vogue to-day are showing the thought which is being expended in this direction, and this fact is proven by the extremely practicable nature and graceful lines which obtain in the most powerful machines.

The exhibit will continue for one week, closing on the following Saturday, January 24. The show is held under the auspices of the Automobile Club of America, the National Association of Automobile Manufacturers and the Madison Square Garden Company, with Frank W. Sanger as manager. During the week annual meetings will be held by the American Automobile Association, the American Motor League and the National Association of Automobile Manufacturers. The latter association will also have its banquet at the Waldorf-Astoria.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

COMPLETION OF PACIFIC CABLE—Consul-General J. P. Bray has reported from Melbourne that the Pacific cable from Australia to London has been completed. The cable is entirely through British territory, and the sections are as follows: Vancouver to Fanning Island, 3,240 nautical miles; Fanning Island to Fiji, 2,093 miles; Fiji to Norfolk Island, 961 miles; Norfolk Island to Brisbane, 834 miles; Norfolk Island to New Zealand, 537 miles.

A LARGE SUPPLY OF PLATINUM DISCOVERED—Foreign cable despatches announce that large deposits of platinum have been discovered on the River Gusseva, a tributary of the Issa, in western Siberia. It is stated that there are now on the field some 25,000 miners who have been digging very industriously and have secured a very large amount of platinum before police restrictions could be effective. It is believed that the new mines will be able, when properly worked, to supply a very large amount of this valuable metal.

PENNSYLVANIA TO DOUBLE ITS CAPITAL AND BONDED DEBT—At the annual meeting of the stockholders of the Pennsylvania Railroad Company, to be held in Philadelphia, March 10, it is planned to ask the stockholders to authorize an addition to the capital stock of the company to make the aggregate $400,000,000, and an increase of the bonded indebtedness to a like amount. The present capitalization of the company, as represented by stock and bonds outstanding, is $328,420,240. After March the total authorized capitalization of the Pennsylvania Railroad Company, common stock and funded indebtedness, if the plans promulgated are carried through, will be $800,000,000.

BROOKLYN RAPID TRANSIT REFUTES CHARGES—Former Lieutenant-Governor William F. Sheehan, counsel for the Brooklyn Rapid Transit Company, in opening the defence of the company against the charges made to the state board of railroad commissioners, characterized many of the complaints as either silly, ridiculous or malicious. Others, he said, were justifiable and would be remedied. He declared that the growth of Brooklyn was dependent upon the extension of its transit facilities, and every obstacle raised in the path of the railway company retarded the development of the borough. In quoting some of the improvements and extensions which the company anticipates making in the near future, he said that within the next ten months $6,000,000 would be spent on betterments, and much more within the next few years in bringing the system up to the public demands.

PERSONAL MENTION.

MR. B. L. HEGEMANN has become interested in an electric lighting establisnment at Bedford, near Cleveland, Ohio, resigning his charge of the Necedah (Wis.) electric lighting plant.

MR. F. M. HAWKINS, New York, the sales agent for the Crouse-Hinds Electric Company, of Syracuse, is greatly pleased with the demand for the new "Norbitt" specialties which his company has introduced. These consist of the latest designs in porcelain appliances, embracing many different forms.

DR. LOUIS DUNCAN, professor of electrical engineering at the Massachusetts Institute of Technology, contributes an excellent study of long-distance electric railroading to the December number of the *Technology Quarterly*. Dr. Duncan has had wide experience in electric railway work, and his views of the present status and the prospects for the future are interesting and valuable.

MR. JAMES LYMAN has been appointed engineer of the Chicago office of the General Electric Company. His predecessor, Mr. E. C. Noe, has been appointed general superintendent of the Northwestern & Lake Street Elevated Railroad Companies. As Mr. Noe's assistant in the Chicago office of the General Electric Company, Mr. Lyman has become well known in electrical circles.

MR. JOSEPH HOWARD, JR., president of the New York Press Club, announces that the thirtieth annual dinner of the club will be given at the Waldorf-Astoria on Saturday evening, February 14, and states that while it is the intention of the club to give the dinner a distinct professional tone, a number of guests will be men eminent in national life. The dinner committee consists of Charles J. Smith, William C. Bryant, Charles D. Platt, John A. Hennessey and George F. Lyon.

MR. MORRIS MOSKOWITZ, who received the John Scott medal of the Franklin Institute for his achievements in electric train lighting, is now the chief electrician of the United States Light and Heating Company, of New York city. Mr. Moskowitz and his associate, the chief engineer of the company, Mr. Henry K. Brooks, have developed a new and very promising system of electric train lighting, in which the mechanical as well as the electrical features have been very carefully worked out.

MR. CARL SCHWARTZ has accepted a position with the Chicago Edison Company as electrical engineer. Mr. Schwartz has been in this country about six months, and before locating in his profession made a tour of the United States studying the various engineering accomplishments of note and also the methods and products of the important electrical manufacturing companies. Before coming to the United States Mr. Schwartz had been prominent in electrical engineering in Germany and Russia.

MR. LAMAR LYNDON, the well-known electrical engineer of New York city, has been absent from his offices in the Park Row Building for several months. Mr. Lyndon's many friends will be glad to learn that he is recuperating and expects to be back in New York early in February. After leaving New York Mr. Lyndon remained in the Adirondacks for some time, and later made his headquarters at Athens, Ga. From this place he has sent us from time to time cheerful assurances of his bettering condition of health.

MR. CHARLES G. BURTON has been appointed manager of the Chicago agency of the Christensen Engineering Company, Milwaukee, Wis. Mr. Burton has been well known in the electrical field for some time, being for several years connected with the Central Electric Company and later with the Westinghouse Electric and Manufacturing Company. He has recently been carrying out some individual projects as a consulting engineer, and he will no doubt prove a very valuable acquisition to the Christensen company.

AUTOMOBILE NOTES.

AMERICAN AUTOMOBILE ASSOCIATION—The annual meeting of the American Automobile Association will be held at 753 Fifth avenue, New York city, at 4 P. M., January 20. It is expected that there will be a very large attendance at this meeting, as the officials of the organization are taking much interest in perpetuating the organization and making it secure for itself a prominent place among different interests.

A CONTEST FOR COMMERCIAL VEHICLES—The Automobile Club of America has projected a plan to hold a contest in the early spring for commercial vehicles. A meeting has been arranged for Thursday, January 22, at 4 P. M., at the club house, 753 Fifth avenue, New York city, so that manufacturers of trucks and delivery wagons and all types of commercial vehicles may come together and perfect rules for such an organization.

THE CHICAGO AUTOMOBILE SHOW—The Chicago Automobile Show will be held from February 14 to February 21, 1903, inclusive. The Central Passenger Association, the Western Passenger Association and the Trunk Line Association covering all the territory between Cheyenne, Wyoming (including all points in Colorado) and New York except New England, have granted reduced rates on account of the Good Roads Convention of the National Association of Automobile Manufacturers. This convention will be held at the Coliseum, Chicago, during the automobile show. The enthusiasm already evinced by the manufacturers of automobiles and kindred appurtenances bids fair to make this exhibition one of the most entertaining and profitable ever held by the automobile fraternity.

ELECTRICAL SECURITIES.

Following the conditions which have obtained in the stock market for the past several weeks, the tendency has been upward throughout. Bullish sentiment prevailed very strongly from the opening session, and the shares averaged close on to a million each day during the week. The growing activity manifested by the outside public in securities has had a very healthy effect on the market in general and has been the means of dissipating any adverse cloud which may have drifted into financial circles. Early in the week there was a decided drop in the rates for call money, and the continued ability of speculative interests to meet their responsibilities made a condition of monetary ease a predominant feature. The excellent showing made by a number of industrial corporations, notably large freight-moving railroad concerns, also acted as a stimulus.

New York:	*Closing.*
Brooklyn Rapid Transit	69¼
Consolidated Gas	219¾
General Electric	187¼
Kings County Electric	212
Manhattan Elevated	153
Metropolitan Street Railway	141¾
New York & New Jersey Telephone	163
Westinghouse Manufacturing Company	218

It is stated that the General Electric Company is now earning at the rate of about $10,000,000 per year or nearly 25 per cent upon its new capital stock of $42,000,000. Some months the earnings have been above $1,300,000.

Boston:	*Closing.*
American Telephone and Telegraph	165
Edison Electric Illuminating	275
Massachusetts Electric preferred	95
New England Telephone	137
Western Telephone & Telegraph preferred	101

A regular quarterly dividend of 2½ per cent has been declared by the Edison Electric Illuminating Company, payable February 2, 1903, to stockholders of record January 14. Mr. Frederick P. Fish has been elected a director to fill the vacancy caused by the recent death of Mr. Edward D. Maltby.

The Boston Elevated directors have reelected officers.

Philadelphia:	*Closing.*
Electric Company of America	10
Electric Storage Battery common	80
Electric Storage Battery preferred	80
Philadelphia Electric	8¾
Union Traction	46¾
United Gas Improvement	111½

It is unofficially stated that Philadelphia Rapid Transit gross earnings for the six months ended December 31 are an increase in excess of $650,000 over the same period of 1901.

The Electric Company of America directors have declared a semi-annual dividend of 3 per cent, payable January 31 to stock of record January 20. Books close January 20 and reopen February 2.

Chicago:	*Closing.*
Chicago Edison Light	172
Chicago Telephone	160
Metropolitan Elevated preferred	88
National Carbon common	26½
National Carbon preferred	97
Union Traction common	15¼
Union Traction preferred	45¾

The annual meeting of the Lake Street Elevated is scheduled for January 29. It is said that the statement will show up about 10 per cent better than last year

The regular semi-annual dividend meeting of the Metropolitan West Side Elevated will be held on or about January 25, when it is stated a dividend of 2 per cent will be declared, making in all for the year 3½ per cent. Daily average passengers carried for the year will come out about 108,000 against 93,000 for the preceding year.

The South Side Elevated shows an increase for December of 11 per cent in number of passengers carried and a daily average for the year of 8.95 per cent.

The annual meeting of the Northwestern Elevated will be held on January 28 at the company's offices in Chicago. During the year the company carried about 23,000,000 passengers as against 20,000,000 for last year, being a gain of 15 per cent. It is estimated that the net earnings, reckoning on this basis of improvement, will amount to about $824,723.

For the month of December the Chicago Telephone Company gained 1,500 telephones.

ELECTRIC RAILWAYS.

ATTICA, N. Y.—Fredonia has granted a franchise for a trolley line to the Lake Shore Traction Company, which will connect Buffalo and Westfield, a distance of sixty-five miles. It is the intention of the company to complete the road within a year.

INDIANAPOLIS, IND.—It is stated that the Union Traction Company may extend its system to Newcastle and Richmond, paralleling the Richmond division of the Pennsylvania Railway from Middletown east. The Union Traction Company has already announced its intention of building a line from Daleville to Middletown next summer.

SOUTH McALESTER, I. T.—Articles of incorporation have been filed by the Purcell & Lexington Street Railway Company, with an authorized capital of $100,000. The object of the company is to build an electric street railway between Purcell, I. T., and Lexington, Okla. William T. James, Thomas C. Woods and J. F. Sharp are the incorporators.

INDIANAPOLIS, IND.—The survey of the Wabash & Rochester trolley line has been completed. The length of the line is thirty-five miles. Work will begin on the line in the spring, and it is hoped to have cars running by next fall. The officers of the company are: President, P. A. Tuttle, Geneva, Ohio; vice-president, Solomon H. Godman, Wabash; secretary, T. W. Latham, Cleveland.

SLATINGTON, PA.—What is to be known as the Siegfried & Danielsville Street Railway Company has been chartered and most of the right of way has been secured. The new road is to run from Alliance to Kreidersville, Pennsville, Cherryville, Harper's and Danielsville, where it will connect with the Slate Bend road. The work on the new line is to be commenced as early in the spring as possible.

SYRACUSE, N. Y.—Hydraulic engineers are at work on a plan to run the Syracuse Rapid Transit Railroad system, the Oswego Railway system and the connecting road to be built from Syracuse to Oswego by electricity generated from water power. Plants are to be established at Fulton, High Dam, Oswego and Minetto, and the rapid transit plant in this city is to be used as an auxiliary plant. It is said unlimited power can be generated. The new connecting road will be double tracked.

ELECTRIC LIGHTING.

BENTON HARBOR, MICH.—The city council has decided to have a municipal lighting plant.

ZANESVILLE, OHIO—The Appleyard Syndicate has acquired control of the Bellaire, Zanesville & Cincinnati Railroad and will change it into an electric interurban line.

PHILADELPHIA, PA.—Track laying for the new Kennett Square-Wilmington trolley road has about been completed in Kennett Square and the entire line will be in operation by March 1.

WATERTOWN, MASS.—The Watertown Gas Light Company is arranging for the building of a new electrical plant, and plans are now being drawn up. The plant is to be finished in the early spring.

JERSEY CITY, N. J.—The United Electric Company has secured a five-year contract for lighting the streets of this city. It is agreed that 1,373 electric lights will be furnished at $97.50 for each light per year.

TACOMA, WASH.—It is announced that the ten-mile electric railway connecting Everett and Snohomish will be built at once by an eastern syndicate at a cost of $150,000. A franchise has already been secured.

MIDDLETOWN, N. Y.—The National Consolidated Company has been incorporated with a capital stock of $50,000 to manufacture gas and electricity for villages in Orange and Sullivan counties. The directors of the company are: Charles M. Priggen and G. R. Larwill, of Brooklyn, and Henry Floy, of New York city.

BANGOR, ME.—The Clinton Electric Light and Power Company has been organized at Clinton for the purpose of supplying electricity or gas for all purposes in the towns of Burnham and Clinton, with $10,000 capital stock. The officers are: President, Frank L. Besse, of Clinton; treasurer, Manly Morrison, of Clinton.

INDUSTRIAL ITEMS.

THE CHRISTENSEN ENGINEERING COMPANY has opened an office in the Merchants' Loan and Trust Building, Chicago, for the sale of "Ceco" electrical machinery. Mr. Charles G. Burton has been secured as the manager of the Chicago agency.

THE MAGNET WIRE COMPANY, 141 Broadway, New York city, manufacturer of all sizes of magnet, weatherproof, annunciator, office, rubber covered, trolley and bare wires, carries in stock in large quantities. The company is able to make prompt shipments, and is doing a remarkable amount of business.

THE SPRAGUE ELECTRIC COMPANY, New York city, has supplied a large amount of flexible metallic conduit and steel armored conductors for the new addition to the White House in Washington, and has also received additional orders for ventilating outfits for the same building.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., is the selling agent for Packard transformers. The Packard vacuum process for transformer insulation has met with great success in electrical construction, and the Electric Appliance Company will give complete information regarding this upon request.

THE WESTERN STEEL CAR AND FOUNDRY COMPANY (Hegewisch), Chicago, Ill., has installed a 12,000 horse-power steam and electric, two-phase alternating-current power plant with complete motor equipment. This company is affiliated with the Pressed Steel Car Company and will make steel as well as wooden cars.

THE COLUMBIA INCANDESCENT LAMP COMPANY has moved to new quarters at 2115 Locust street, St. Louis, Mo. The new building, which has been designed and constructed for the making of lamps, is three stories high and is fitted with every appurtenance which contributes to the completion of a modern establishment.

THE MARSHALL-SANDERS COMPANY, Boston, Mass., has recently perfected a very ingenious elastic fibre lining for its sockets, which is said by construction men and others to be a money-saving improvement. This lining does not shake out, but can be easily removed with the fingers. At the same time, it is tough and not easily broken, it being possible to crush it considerably and have it still retain its original shape.

THE GRAND RAPIDS EDISON COMPANY, Grand Rapids, Mich., recently put in a 3,000-ampere storage battery and erected a building for this battery and other purposes, 100 by 55 feet, built throughout of concrete. This company will shortly develop a 1,000-horse-power water-power plant at a distance of eighteen miles from Grand Rapids, transmitting an alternating current to Grand Rapids where the current will be converted.

THE FOSTORIA BULB AND BOTTLE COMPANY, of Fostoria, Ohio, wishes to correct the impression that its plant has been destroyed by fire. Another glass factory at Fostoria, Ohio, bearing a different name, which manufactured outer globes and shades for arc lamps, was destroyed by fire, hence this erroneous impression. On the contrary, the company is in excellent condition to furnish large shipments, and its production of inner globes has been greatly increased.

THE INDEPENDENT INCANDESCENT LAMP COMPANY, successor to the United States Incandescent Lamp Company, manufacturer of "Independent" high-grade incandescent lamps for all systems, St. Louis, Mo., has opened headquarters for business in the commodious premises formerly occupied by the Columbia Lamp Company. Orders are now being filled, and several large contracts have already been secured. Mr. Walter Ennes is the sales manager, with offices at 1910 Olive street.

THE H. W. JOHNS-MANVILLE COMPANY, New York city, is placing a new product on the market, bearing the trade name of "Salamanderite." The basic construction of this material is asbestos, and it is stated to be absolutely fireproof. It is furnished in sheets or panels in various thicknesses from one-eighth to one-half inch, finished on one side in exact fac-simile of any fancy cabinet work, plain and in bas-relief. The company has recently issued also a catalogue descriptive of its asbestos specialties. This is a valuable addition to the literature on the subject, and any one who is contemplating the use of fireproofing material of any description, would do well to secure one of these very complete catalogues.

JOSEPH P. MENCHEN, New York city, inventor, patentee and manufacturer of improved electrical theatrical appliances, has met with more than usual success in the equipping of theatrical settings for the production of startling effects. During the present season the great flexibility and facility of electrical forms of illumination have made it very popular, and enterprising managers have vied with one another to produce the most gorgeous effects. Among the specialties which Joseph P. Menchen has made with particular success are the "Olivette" or open box lights, the lens boxes or spot lights or chasers, sciopticons which represent water ripple or moving cloud effects, and the Menchen stage receptacle and attaching plug. A novelty which has recently been introduced is an attaching plug of vulcabeston. This is for use where connections must be made very rapidly and broken rapidly, and where it occurs continuously and with great frequency. These plugs are made in any capacity up to fifty amperes, and have been used with great success in some very severe applications.

AMONG RECENT DECORATIONS installed with the Norbitt temporary decorative socket, was that of E. S. Brown Company, of Fall River, Mass., the largest department store in New England. The decoration consisted of 2,700 four-candle-power lamps, and about 1,000 eight-candle-power lamps. The entire equipment was installed in less than forty-eight hours, and most of it by unskilled labor, as the firm did the entire equipment itself, under the supervision of one of the members of the firm. Another large installation was that by a large Baltimore contractor for the wedding of the daughter of Dr. Emerson, of Bromo-Seltzer fame. This decoration consisted of about 1,500 Norbitt temporary decorative sockets. Among other installations were those of the Delaware Club, December 9, at Terrace Garden, New York, 2,100 lights, and the Bachelor Circle or the German Liederkranz Society, at its club house in Fifty-eighth street, January 8. The demand for these sockets has been very great. Mr. F. M. Hawkins, the sales agent for the manufacturer, Crouse-Hinds Electric Company, at 23 Dey street, New York city, carries a complete stock of these specialties.

AMONG THE MANY CALENDARS received are the characteristic "Great Men of Science and Engineering" from the Bullock Electrical Manufacturing Company, Cincinnati, Ohio; this is adorned with a miniature of James Prescott Joule, with a biographical sketch on the reverse side. Rossiter, MacGovern & Company, electrical and steam machinery, main office, 141 Broadway, New York city, has issued a calendar with a brilliantly colored representation of an incandescent lamp outshining the brilliance of the sun. Walsh's Son & Company, wholesale dealers in scrap iron and metals, Newark, N. J., a practical memorandum calendar and diary pad. John A. Roebling's Sons Company, New York city, a handsome calendar with a half-tone reproduction of the cable work on the new East River Bridge. The Standard Tool Company, manufacturer of twist drills, Cleveland and New York, an attractive calendar in blue and gold, the date-pad being supplemented by some valuable information for machine men. The Lombard Governor Company sends a handsome calendar with a beautiful reproduction of a painting by W. Weber, entitled "Moonlight at Sea;" this is in colors and represents very accurately the brush effect on canvas; the Lombard Governor Company's headquarters are at 36 Whittier street, Boston, Mass. N. W. Ayer & Son, 300 Chestnut street, Philadelphia, sends a very large calendar adorned with an attractive bas-relief symbolical of advertising methods and advertising success. Title Guarantee and Trust Company presents its friends with a handsome calendar, the figures being plainly seen and the panel being adorned with a photogravure, representing the purchase of Manhattan Island by Peter Miniut in 1626; the first page of the calendar pad gives an historical sketch of this important matter of history. The Audit Company, of New York, adorns its calendar with an allegorical representation of Justice; this picture is a reproduction of a part of the freize of the entrance hall of the building occupied by the Appellate Division of the Supreme Court of the State of New York; the painting represents Justice holding the symbols of the law—a sword, a book and scales, with peace and prosperity on either side. The F. A. Ringler Company, high-class engraver and art copper worker, sends the season's compliments.